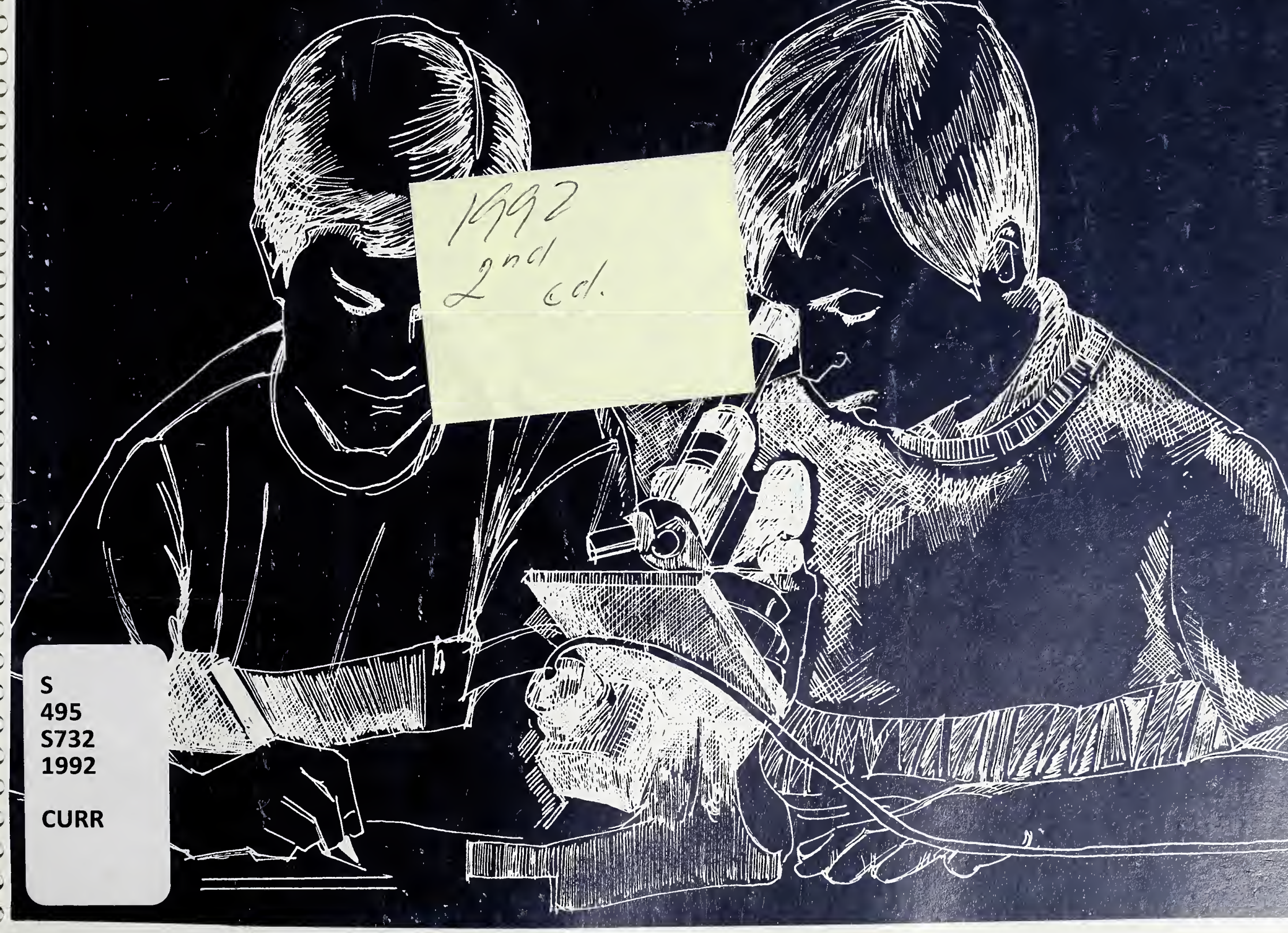
Alberta
AGRICULTURE

SPACE AGE AGRICULTURE

SCIENCE



1992
2nd ed.

February 1992 - 1500 copies
For further information contact:

Alberta Agriculture
Ag. in the Classroom Program
Agricultural Education Branch
2nd Floor, 7000 - 113 Street
Edmonton, Alberta T6H 5T6

Phone: 427-2402

SPACE AGE AGRICULTURE

A Resource Book For Teachers
Division 3, Science

Written by John Archibald

ALBERTA AGRICULTURE

First edition - 1988
Second edition - 1992

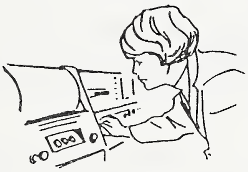
INTRODUCTION

Welcome to Space Age Agriculture. In writing this booklet I aimed to provide lessons that you can fit into your everyday teaching. The procedures are intended to be clear and detailed enough that you can use them directly if you wish. At the same time they are only suggestions, and I hope you will feel free to adapt and modify them to suit your needs and your students' interests.

This booklet deals particularly with Science at the junior high level. It is part of a three book set. The other Division 3 volumes were prepared for Social Studies and for the Agriculture option. Each book in the set aims to show users that:

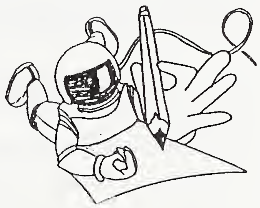
- agriculture is affected by each school subject area, and
- agriculture is a diverse endeavor that affects even the most urban Albertans.

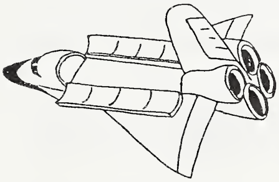
Agriculture in the Classroom booklets at all grade levels are written to teachers like yourself. Space Age Agriculture is no exception. Throughout the book however, there are certain specialty pages that are identified graphically.



Pages marked with this symbol are extended references for you. In classroom explorations you provide ground control, monitoring student effort and guiding students back to earth.

This symbol indicates a student task sheet. Your students act as astronauts exploring the intellectual space and recording their findings.





Pages with this symbol are student resource sheets. They contain information directly useful to the work required by task sheets.

At the start of each activity, some rakish cartoon characters will put in an appearance. These are Rake and his family, who are there for comic relief. Rakes are simple tools, but they are appropriate theme characters for Space Age Agriculture because their purpose is to gather things, much like the purpose of students is to gather information.

This booklet may contain terminology that is unfamiliar to you or to your students. To help, we have included a glossary. It contains definitions of unfamiliar words that are in the text.

In Space Age Agriculture we aim for direct links with the Alberta school curriculum. In this case, our focus is the 1990 revision of the Program of Studies for Division 3 Science. Each lesson includes a description of what unit it supports, and what concepts it reinforces within that unit. Feel free to apply the ideas here to topics in other units if that seems appropriate.

This is the second edition of Space Age Agriculture. Throughout this year we will be seeking your feedback regarding how lessons work, what modifications you try, where you need expansion or contraction, and any of your other responses. Through this process we hope to produce a resource that any teacher can use effectively in a classroom.

Alberta Agriculture film library or publications library may have some additional relevant resources. We encourage you to write for a publication list and film catalogue. They are available from:

Alberta Agriculture
Publications Office or Film Library
7000 - 113 Street
EDMONTON, Alberta
T6H 5T6

CREDITS

ORIGINAL EDITION

Production:	Alberta Agriculture Agricultural Education Branch
Writer:	John Archibald
Editor in Chief:	Cole Pederson
Proof Reading:	Cole Pederson, Cindy Dixon, Alaine Roberts, Julie Gregor
Consultant/Producer:	Betty Gabert
Artwork and Production:	Cole Pederson, Cindy Dixon
Word Processing:	Alaine Roberts

REVISION

Production:	Alberta Agriculture Agricultural Education Branch
Editor:	Gary Taljit
Artwork:	Roberta Mazurenko
Consultant:	Betty Gabert
Proof Reading:	Betty Gabert
Layout:	Cindy Dixon
Typing:	Julie Splawinski
Typesetting:	June Gingras
Project Management:	Betty Gabert

TABLE OF CONTENTS

PAGE

TABLE OF CONTENTS (cont'd)

GLOSSARY

additives	a food additive is defined by the Canadian Food and Drug Regulations as "any substance, including any source of radiation, the use of which remits or may reasonably be expected to remit in to or its by- products becoming a part of or affecting the characteristics of a food". Food additives are used in food to: maintain its nutritive quality; enhance its keeping quality; make it attractive; and, aid in its processing, packaging or storage. In general, food additives do not include salt, sugar, starch, vitamins, minerals, amino acids, spices, seasonings, flavoring preparations, agricultural chemicals, veterinary drugs or food packaging materials.
agar	gelatinous substance used as a bacterial culture.
aggregate	a single mass consisting of many soil particles held together, such as a clod, prism, crumb, or granule.
analogue	a synthetic food product made of vegetable matter (as soybeans) and used as a meat substitute.
artificial insemination	a process in which semen from a male animal is collected medically, and may be stored, or transported before being injected into a female of the same species.
autoclavable	having the ability to be sterilized with pressurized stream.
auxin	an organic substance (plant hormone) that is able in low concentration to promote longation of plant shoots and to control other growth effects.
blade	the flat, expanded part of a leaf.
bud	a small lateral or terminal protuberance of the stem of a plant that may develop into a flower, leaf or shoot.
capital intensity	refers to the fact that many of the various sectors of the agriculture industry require large amounts of capital to start-up and operate.
chimera	an offspring with four parents produced by the fusion of two living embryos.
clone	a living thing that is grown from normal body cells of its parent. All clones of one parent are genetically identical to it and to each other.
cocoon	the silky outer covering which the larvae of certain insects spin around themselves before passing to the pupa stage.
control	an experiment in which the subjects are treated as in a parallel experiment except for omission of the procedure or agent under test and which is used as a standard of comparison in judging experimental effects.
crop rotation	a systematic changing of crops grown in the same land to help prevent soil exhaustion and to guard against creating suitable conditions for pests to flourish.
cross breeding	the propagation of new individuals by breeding two distinctive varieties of a species.
cruciferous	refers to any plant of the mustard family, such as cabbage, radish, turnip, etc.

GLOSSARY (cont'd)

cutting	plant section originating from stem, leaf or root and capable of developing into a new plant.
cytokinin	plant hormone that is derived from aderime and is active in stimulating cell division.
defoliation	the removal of the foliage (leaves) from a plant.
dry ice	a solid formed by freezing carbon dioxide. It has a temperature of -78.5 degrees Celsius and it changes directly to a gas at all ordinary air pressures.
efficient producers	in terms of the Alberta Egg and Fowl Marketing Board, efficient producers are determined from a national survey of producers who have between 8,000 and 50,000 laying hens.
egg cells	see OVA
embryo	an animal in the earliest stages of development prior to birth
enrich	to improve the nutritive value of a food by adding nutrients (as vitamins or amino acids) and especially by restoring part of the nutrients lost in processing.
entomologist	a person who specializes in the study of insects.
estrus	the time following ovulation during which a female animal is fertile and will accept an attempt to mate.
ethanol	(ethyl alcohol or C_2H_60) - a colorless, volatile, flammable liquid that is the intoxicating agent in fermented and distilled liquors and is used also as a solvent.
fabricated foods	synthetic foods which resemble natural foods; also natural foods which have been remade into a different form.
fertilize	to impregnate the ova or egg with male sperm, allowing for the creation of offspring.
foodchain	an arrangement of the organisms of an ecological community according to the order of predation in which each uses the next as a food source.
foodweb	the totality of interacting food chains in an ecological community.
fungicide	any chemical which kills or inhibits fungi.
gel	the semi-solid form of a mixture of water and some other large molecule, e.g. gelatin. Heating, diluting and salting will convert these mixtures from gels to a fluid called a sol.
gene	a chemical unit in each cell of a living thing that controls the inheritance of its hereditary traits.
genetically identical	having the same set of genes as another living thing. This occurs in identical twins and in clones.
gibberellin	any of several plant-growth regulation that in low concentrations promote short growth.
hardwood cutting	a mature shoot of the last season's growth which is removed from the plant after the leaves have fallen to be used in propagating new plants.

GLOSSARY (cont'd)

heat units	used to measure the temperature requirements of corn. Head units are based on day temperatures about 10 C and night temperatures above 4 C from May 15 to the first killing frost (-2 C).
herbicide	any chemical which is used for killing plants.
hormone	a chemical produced in certain body cells that circulates in the blood (or the sap of plants) and activates cells that are distant from its origin.
hydroponic solutions	nutrient solutions - in which plants can grow without the benefit of soil.
implant	to insert an object, such as an embryo, into another living organism using medical procedures; the object that is inserted.
insecticide	a substance that kills insects by chemical action.
invertebrate	any animal which does not have a backbone or spinal column, i.e. worms and insects.
keds	wingless, louse-like flies that attach themselves to animals like sheep and suck on their blood.
larva (plural is larvae)	the immature form of insects and other small animals, which is unlike the parent or parents and which must undergo considerable change of form and growth before reaching the adult stage.
layering	a method of propagation where runners from a parent plant are encouraged to root and establish new plants.
legume	any plant of the large family that includes the peas, beans and clovers.
loamy	a soil that is not sandy or clayey, but is well supplied with organic matter. Technically, a soil which contains 7 to 27% clay, 28 to 50% silt and less than 52% sand.
metamorphosis	a process by which an organism changes in form and structure in the course of its development, as many insects do.
microbes	see microbial populations.
microbial populations	organisms, such as germs, of microscopic size
microsporidians	minute spores that can be intracellular parasites of insects.
mineral matter	the inorganic components of soil.
nodule	a small mass of rounded or irregular shape; in plants, a swelling on the root that contains bacteria.
nymph	a stage in the development of some insects and related forms, such as ticks, immediately preceding the adult stage.
organic matter	in farming practice, the animal manures and plant growth added, plowed under and thus incorporated with the soil.

GLOSSARY (cont'd)

organism	general term for living things, used to include plants, animals and microbes.
ova	plural form of ovum, a female reproductive cell; an egg.
ovipositor	a tubular structure in female insects, used for depositing its eggs.
ovulation	the release of a mature ovum from the ovary so that it may be fertilized.
parasite	an organism that lives at least for a time on or in and at the expense of another living organism.
partheno-genetically	parthenogenesis refers to the development of an individual from an unfertilized egg cell.
pasteurization	the process of sterilizing substances, such as milk, by heating and then cooling.
pathogen	a disease-producing microorganism or virus
pathogenic	capable of causing disease.
pipette	slender tubes for transferring or measuring small quantities of liquids.
peptone	a protein derivative soluble in water and non-coagulable by heat; used as a nutrient and to prepare nutrient media for bacteriology.
pesticide	a substance which is used to control insect, plant or animal pests.
petiole	the stalk that attaches the leaf of the stem.
plant hormone	an organic compound that is synthesized in minute quantities in one part of a plant and translocated to another part, where it influences a specific physiological process.
porespace	the portion of a given volume of soil which is not filled with solid matter: air spaces, irregular in shape and size.
precipitate	a substance separated from a solution or suspension by chemical or physical change usually as an insoluble amorphous or crystalline solid.
predatory insects	refers to insects which prey on other insects for food.
processed food	food that has been modified before reaching our mouths by means of a number of treatments, i.e. pasteurization, wood making, addition of chemicals, etc.
propagation	the act of causing a plant or animal to generate or to multiply by sexual or asexual means.
pupa (plural is pupae)	the inactive stage during which an immature insect or larva transforms to the adult.
quota	a proportional part of share assigned to each member of a body

GLOSSARY (cont'd)

scavenger	an insect or other organism that feeds on carrion or dead organic matter.
scientific method	the systematic collection and classification of data and usually the formulation and testing of hypotheses based on the data.
selective breeding	breeding of animals or plants having desired characteristics.
silage	any material harvested in a green state and preserved in a succulent condition by partial fermentation in a container as a silo.
softwood cutting	an immature, succulent stem taken from a plant which is used for rooting or grafting.
soil texture	the physical nature of the soil according to composition and particle size.
specialization	structural adaptation of a body part to a particular function.
sulfuric acid (H_2SO_4)	a heavy, corrosive, oily acid that is colorless when pure and is a vigorous oxidizing and dehydrating agent.
summerfallow	the plowing of a field prior to or during the summer and cultivating enough to control weeds in preparation for a later crop.
supply management system	refers to a system where production limits are maintained. This ensures that market prices and producer incomes remain stable.
surrogate	anything that acts in place of another (substitute).
systemic insecticide	a substance which, when absorbed by plants, or injected or given orally to animals, renders the plants and animals toxic to insects feeding on them.
taxonomy	orderly classification of plants and animals according to their presumed natural relationships.
thrips	very small insects of the order nrysanspera, for the most part very injurious to plants.
tillage	the practice of working the soil to bring about more favorable conditions for plant growth.
tissue culture	a group of similar cells removed from the organism in which it developed and grown in an artificial laboratory medium.
tonnes per hectare	the metric weight of crops harvested from an area equal to 2.47 acres.
topography	representation of a surface and its features, such as streams, lakes, woods, etc.
transponder	a device that will receive a signal and emit its own signal.

GLOSSARY (cont'd)

unpasteurized milk raw milk which has not been heat-treated to remove microbes.

uterus the womb; an organ in which the young develop before birth.

vegetative propagation reproduction of new plants by asexual means. This includes leaf, stem or root cuttings, etc., done by human hands. It also refers to the formation of bulbs, tubers and rhizomes, etc. by the plant itself.

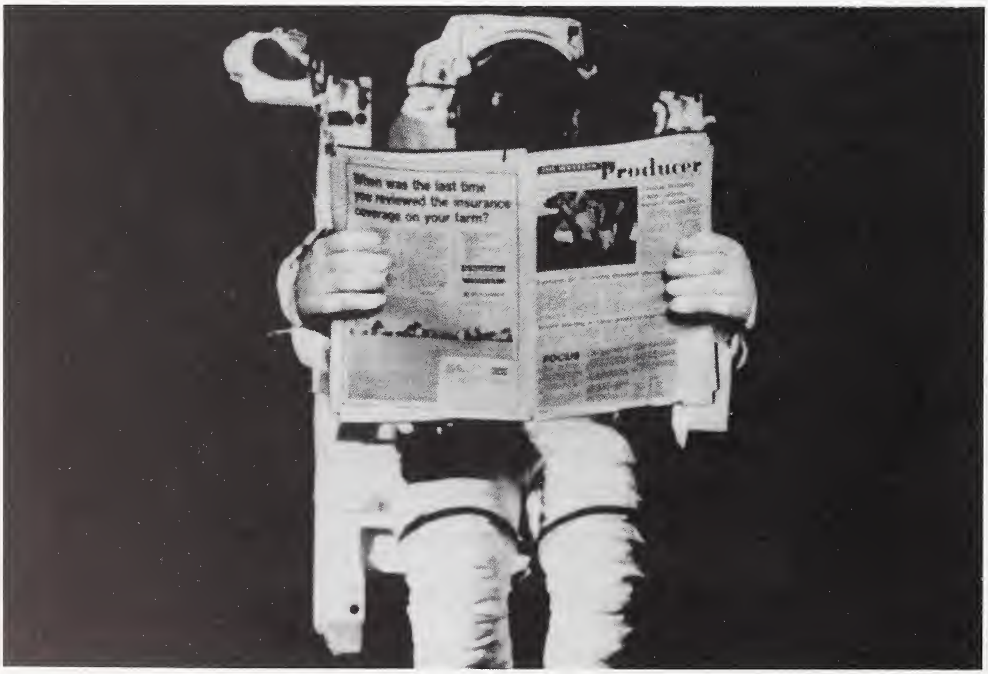
Sources used in compiling this glossary include:

A Dictionary of Agricultural and Allied Terminology

McGraw-Hill Dictionary of Scientific and Technical Terms, 3rd edition

The Concise Oxford Dictionary, 7th edition

Webster's Ninth New Collegiate Dictionary



CURRICULUM CONNECTION

SPACE AGE AGRICULTURE SCIENCE - Grades 7-8-9

LESSON TITLE	CURRICULUM FIT/ LESSON CONCEPT	MAJOR AGRICULTURAL CONCEPTS	COGNITIVE LEVEL	OBJECTIVES AND SKILLS
1. **Mission Impossible**	Program Context: The Nature of Science, Technology Biotechnology, Applied genetics, Transplants, Transmitters, Problem solving, Remote sensing.	Technology and Capital Intensity Diversity of Agriculture	Application	Students will use science process skills in solving modern agriculture problems which rely on recent advances in biotechnology.
2. **So, Who Cares When it Rains?**	**Grade Seven** - Topic 1: Characteristics of Living Things **Grade Eight** - Topic 5: Growing Plants. Response of an organism to stimuli. Appreciation of challenges faced by farmers.	Importance of Soil and Water	Application Synthesis Evaluation	Students will observe how a growing cereal grain plant responds to different watering regimes.
3. **Why Pasteurize Milk?**	**Grade Seven** - Topic 5: Micro-organisms and Food Supplies Role of micro-organisms in food spoilage. Technologies for preparing, pre-serving and protecting human food. Safety standards for preparing and handling food.	Technology and Capital Intensity Production, Processing and Marketing System	Application Analysis	Students will determine the effect of pasteurization on microbial populations and shelf life of milk.
4. **Mothers of Invention**	**Grade Eight** - Topic 2: Energy and Machines. Applications of mechanical sys-tems. Inventing a device that makes efficient use of energy. Technology is concerned with the solution of practical problems.	Technology and Capital Intensity Production, Processing and Marketing System	Application Synthesis Evaluation	Students will design, construct, test, and market a simple agricultural machine.

SPACE AGE AGRICULTURE SCIENCE - Grades 7-8-9

LESSON TITLE	CURRICULUM FIT/ LESSON CONCEPT	MAJOR AGRICULTURAL CONCEPTS	COGNITIVE LEVEL	OBJECTIVES AND SKILLS
5. **The Human Incinerator**	**Grade Eight** - Topic 3: Consumer Product Testing Consumer product characteristics and composition. Researching skills.	Technology and Capital Intensity Production, Processing and Marketing Systems	Analysis	Students identify all of the food and non-food substances that they ingest in a week and trace them back to their original sources. They then develop a web to display these results.
6. **Consumer Report**	**Grade Eight** - Topic 3: Consumer Product Testing. Standards for product composition, packaging, labelling and advertising.	Technology and Capital Intensity Production, Processing and Marketing Systems	Analysis Evaluation	Students will perform various tests on different brands of bread in order to write a "consumer report".
7. **Soil and Seedlings**	**Grade Eight** - Topic 5: Growing Plants. Germination, Growth patterns, Soil nutrients and fertilizers.	Importance of Soil and Water	Analysis	Students will design a method or device to monitor seedling growth and use it to compare the effects of varying conditions on that growth.
8. **Let it Grow**	**Grade Eight** - Topic 5: Growing Plants. Plant propagation by vegetative reproduction (i.e. cuttings).	Importance of Soil and Water	Comprehension Application	Students will grow some new plants from cuttings of non-reproductive tissues from old plants.
9. **Saskatoon Pie**	**Grade Eight** - Topic 5: Growing Plants. Plant propagation by vegetative reproduction. Flowering and seeds. Specialized varieties, plant breeding. Awareness that agricultural plant varieties are usually the product of intensive breeding.	Diversity of the Industry Technology and Capital Intensity	Synthesis Application	Students will develop a strategy for domesticating a wild plant that produces edible fruit.

SPACE AGE AGRICULTURE SCIENCE - Grades 7-8-9

LESSON TITLE	CURRICULUM FIT/ LESSON CONCEPT	MAJOR AGRICULTURAL CONCEPTS	COGNITIVE LEVEL	OBJECTIVES AND SKILLS
10. Dirty Business	**Grade Eight** - Topic 5: Growing Plants. Topic 6: Interactions and Environments. Germination. Soil components and nutrients. Abiotic factors in the environment.	Importance of Soil and Water	Analysis	Students will learn how soil texture affects plant growth by performing settling tests, porosity tests, and seed growth tests.
11. The Incredible Nation-Wide Balancing Act	**Grade Eight** - Topic 6: Interactions and Environments. Awareness of the complex inter-relationships among living things and their environments. Awareness of the nature and extent of impacts on environments caused by human actions.	Economic Importance	Comprehension Application Evaluation	Through applying several class-room activities to agricultural case studies, students will be able to define optimum and maximum as these concepts apply in agriculture.
12. Don't Bug Me	**Grade Eight** - Topic 6: Interactions and Environments. **Grade Nine** - Topic 1: Diversity of Living Things. Food chains and food webs. Interdependencies of living things. Adaptation in structure and behaviour. Systems of classification - dichotomous grouping.	Economic Importance of Agriculture Production, Processing and Marketing Systems	Comprehension Evaluation	Students will identify an insect, relate structure to function in terms of insect feeding habits, and propose efficient pest control methods.

SPACE AGE AGRICULTURE SCIENCE - Grades 7-8-9

LESSON TITLE	CURRICULUM FIT/ LESSON CONCEPT	MAJOR AGRICULTURAL CONCEPTS	COGNITIVE LEVEL	OBJECTIVES AND SKILLS
13. Worm Ranch I	**Grade Eight** - Topic 6: Interactions and Environments. Interaction of living things and environments. Light, soil and temperature needs. Food chains and food webs.	Importance of Soil and Water	Knowledge Comprehension Application	Students establish, observe and interpret an earthworm colony in stratified soil.
14. Worm Ranch II	**Grade Eight** - Topic 6: Interactions and Environments. Interaction of living things and environments. Light, soil and temperature needs.	Importance of Soil and Water	Comprehension Application Analysis	Students drench vivariums with water, observing and recording the patterns water follows through the soil.
15. Where Did You Get That?	**Grade Eight** - Topic 5: Growing Plants. Topic 6: Interactions and Environments. Soil nutrients and fertilizers. Food chains and food webs.	Production, Processing and Distribution System	Analysis Synthesis	Students will convert a mass of oral and visual information into a simplified flow diagram.
16. How Much Food For Plants?	**Grade Eight** - Topic 5: Growing Plants. Soil nutrients and fertilizers. Calculating accurately. Drawing conclusions from evidence.	Technology and Capital Intensity Production, Processing and Distribution System	Application	Students will calculate the amounts of various commercial and non-commercial fertilizes needed to supply nutrients for crops.

Activity 1

MISSION IMPOSSIBLE

OBJECTIVE: Students will use science process skills in solving modern agricultural problems which rely on recent advances in biotechnology.

CURRICULUM FIT: Program Context: The Nature of Science, Technology

- Biotechnology
- Applied genetics
- Transplants
- Transmitters
- Problem solving
- Remote sensing

AGRICULTURE CONCEPTS: Technology and capital intensity
Diversity of agriculture

COGNITIVE LEVEL: Application

MATERIALS REQUIRED: Problems (attached)
Problem-solving format (attached)

TIME REQUIRED: 20 minutes per item

BACKGROUND - For the Teacher

Scientists use a problem-solving approach to develop state-of-the-art technology. Biotechnology involves the use in industry of artificially altered living organisms or their components (e.g. hormones). Powerful new genetic technologies which have been discovered and applied to agriculture play a major role in improving the speed, efficiency, and productivity of plants and livestock.

In terms of your Program of Studies for Division III Science, this lesson addresses Program Context. Students will use a scientific approach to solve some seemingly unsolvable problems. The enclosed format leads students to use such science process skills as interpreting data, formulating models, inferring and communicating. These help the student to understand the impact of biotechnology on the agricultural industry.

Any of the problems can stand on its own. Therefore you can use a version of this lesson whenever your students have some time available to devote to creative thought and to investigating the nature of modern technology. As an alternative, after you have used this lesson once with the whole class, you can set it up as a work station for students who finish other work ahead of time.

Some students may be able to write new problem and solution card sets based on newspaper or magazine articles about new developments in agriculture.

PROCEDURE

Part 1
Preparation

1. Make about 10 copies of the "Problem Solving Format" (attached).
2. Photocopy the Problem-Solution pages and cut out the individual cards.

> NOTE
> Pre-read the cards in case your students will need some background introduction.

3. If you are going to use this lesson frequently or set it up as a permanent work station you should mount each problem and solution step on an index card and plasticize them.
4. Mix the solution step cards up so they are at random.

Part 2
Introduction

5. Divide your class into groups of 3.
6. Give each group a copy of the Problem Solving Format and explain that they are going to use this format to solve some modern agricultural problems.

Part 3
The Activity

7. Have someone from each group choose a problem card.
8. Spread the solution step cards around the room while the groups consider their task.
9. Allow the students 5 minutes to find 4 cards that produce a logical solution to their problem.

Part 4
Conclusion

10. Have one elected spokesperson from each group present the group's solution to the class.

NOTE
You can insert a single problem into any class, or you can devote an entire class to solving problems.

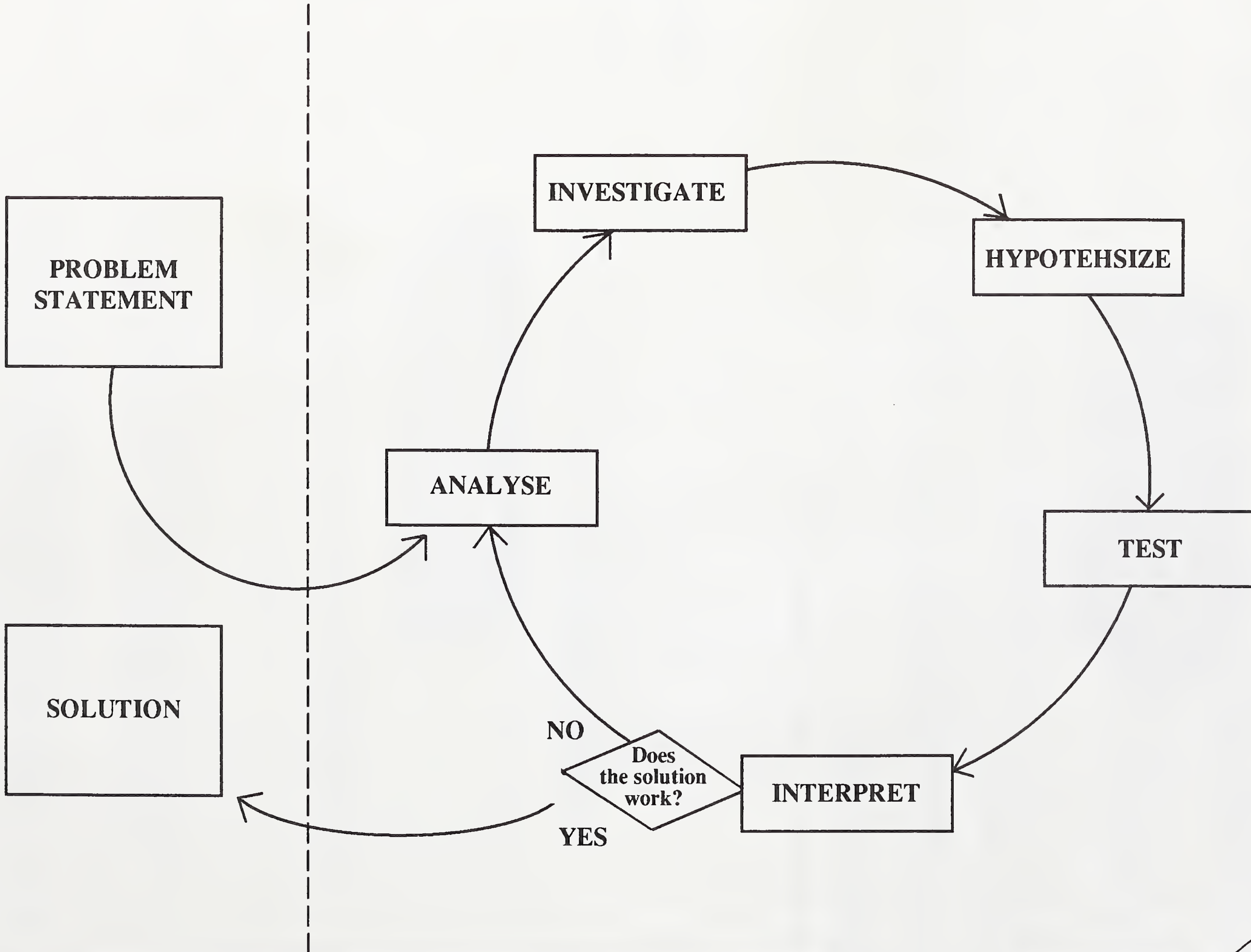
RELATED ACTIVITIES

1. Visit or invite a guest speaker from a private or government laboratory that is involved in biotechnical research.

OUTSIDE ACTIVITIES

1. Improving the Odds (video tape), Alberta Agriculture.

Problem Solving Format



Agricultural research - a field test plot.

Agricultural research - hand pollinating plants.

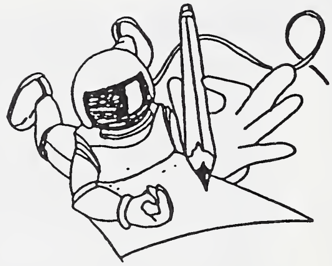
PROBLEM

Good day, Agent AgSci.

Your assignment is to deliver 1000 head of cattle to Australia in two days. You must remain with them at all times, and transport them in two pieces of aircraft carry-on luggage.

Thank you for having volunteered.

T.



Recovery, Storage and Transport of Embryos

1. Fertilized ova (calf embryos) can be removed from a mother cow and kept alive in a laboratory dish.

2. Collected embryos can be stored indefinitely by freezing them.

3. Frozen embryos can be transported in an insulated case kept cold with dry ice.

4. A veterinarian can implant a calf embryo into any mature cow.

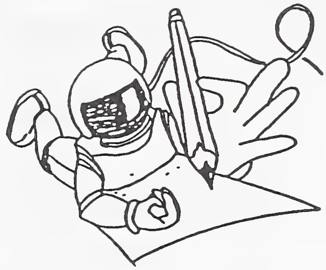
PROBLEM

Good day, Agent AgSci.

Your assignment today is to develop a better feed for Alberta dairy cattle. The feed must be as cheap as farmers use now, but cows must produce more milk when they eat it.

Thank you for having volunteered.

T.



Plant Breeding for Lower Heat Requirements

1. Field corn yields more tonnes per hectare of silage than typical Alberta feed grains like barley. Furthermore, each kilogram of corn silage has more energy than barley or other hay silage.

2. Most varieties of field corn can only grow where the growing season has 2800 heat units each year. Central Alberta's summer has about 2000 heat units.

3. Through selective breeding scientists have developed a type of corn, called Pioneer 3995, that will mature with only 2150 heat units per summer.

4. Even though corn needs more fertilizer and herbicide than barley, it returns about $280 more feed per hectare planted to the farmer.

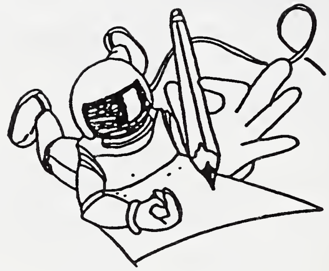
PROBLEM

Good day, Agent AgSci.

Your assignment today is to transport 10,000 artificially cloned tomato seedlings to Lyons, France. These tissue cultures are very fragile and must be kept moist throughout the trip.

Thank you for having volunteered.

T.



Artificial Seed Capsule

1. To cushion the seedling cultures and protect them from drying, you need a coating that will contain a water supply but can be dissolved from the outside.

2. Water can be prevented from dissolving materials by trapping it in a gel. This is a material in which micro-droplets of water are surrounded by molecules of some other substance. It gets its name from gelatin which is the best known example.

3. Suspend the seedling culture in a gel; surround the gel with a water- soluble plastic coating; transport the resulting artificial seeds in any dry box.

4. When the artificial seeds are planted, soil water will dissolve the plastic and dilute the gel. This will free the seedling culture which can begin to grow.

PROBLEM

Good day, Agent AgSci.

Your new assignment is to help an Alberta farmer keep track of crop conditions on 17 widely separated quarter-sections. Information must be visual and relayed to him at his farm headquarters.

Thank you for having volunteered.

T.

Remote Sensing

1. The resource satellite Landsat circles the earth several times each day, and gathers data based on how much light is reflected by the earth's surface.

2. From this reflection, Landsat can record topography, local weather patterns, surface soil color, soil moisture, and vegetation.

3. The information Landsat gathers is stored and transmitted in computer language, but it is commonly displayed as a map with different conditions shown by different colors.

4. A series of Landsat recordings allow a farmer to assess the conditions, trends and rates of change for either crops or pastures.

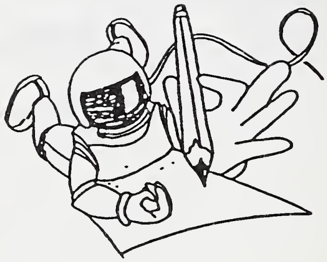
PROBLEM

Good day, Agent AgSci.

Your assignment today is to help a rancher trace the movements of a herd of cattle that pasture on open range in South-central Alberta. The information must be available at the ranch office, anytime of the day or night, and as soon as it is gathered.

Thank you for having volunteered.

T.



Biomedical Telemetry Radio Waves Transmitter

1. Scientists have developed a tiny radio transmitter (1 cm in diameter, 3 cm long) that, if implanted in a cow, will emit a signal every 5 minutes for 5 - 10 years.

2. The signal from this transmitter can be picked up by an antenna on a hilltop, relayed to a receiver and decoded by a computer at the ranch office.

3. This radio/computer system can gather and separate information on the location, health and identity of up to 1000 head of cattle.

4. One of these transmitters can be fed to a cow like a pill, and once swallowed will remain in the animal's first stomach as long as it lives.

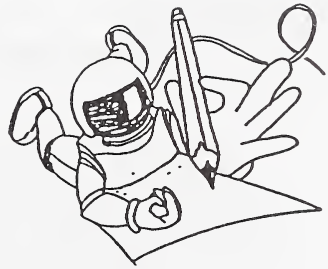
PROBLEM

Good day, Agent AgSci.

Your assignment today is to make it possible for a sandwich packager to extend the time his product can be stored at room temperature without going stale.

Thank you for having volunteered.

T.



Vacuum Packaging

1. Food spoils when oxygen inside a package combines with fatty products in the food to produce humidity.

2. Freezing, cooking, drying and salting all prevent spoilage, but all cause changes in the flavor or texture of the food.

3. Pumping the air out of a package and sealing it under vacuum conditions will prolong a food's shelf life while protecting its flavor. Gas-proof packaging materials are required.

4. Oxygen can be displaced by pumping nitrogen or carbon dioxide gas into the package. Either gas will stop the spoiling process, while also providing enough inside pressure to prevent air from leaking back in.

PROBLEM

Good day, Agent AgSci.

Your assignment is to find a way to determine whether cows are pregnant or not. Your method must work in the first month of their pregnancy.

Thank you for having volunteered.

T.

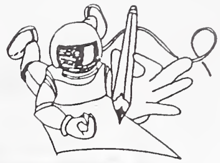
Ultrasound Wave Transmitter

1. An ultrasound transmitter gives off high frequency sound waves. The waves travel in constant patterns until they reach a change in density. A density change reflects waves back toward their source.

2. When a cow is pregnant, body fluids accumulate in her reproductive organs so that their density increases.

3. An ultrasound machine that works like airport radar and submarine sonar, sending out waves and reading their echoes, should be able to detect pregnancy by identifying the fluid buildup that goes with it.

4. An ultrasound transmitter must directly touch the skin with no air gap. Shave the hair from a patch of abdominal skin, coat the transponder with mineral oil or petroleum jelly and hold it firmly in place.



PROBLEM

Good day, Agent AgSci.

Your assignment today is to raise the milk output of healthy well fed dairy cows by 30%. This increase must occur within a month.

Thank you for having volunteered.

T.

NOTE
Somatotropin occurs naturally in milk. Injecting a cow with extra somatotropin will increase the production of milk, but will not raise the level of somatotropin in that milk. Research has shown that bovine somatotropin poses no health concerns for humans. However, the commercial use of somatrotropin to increase milk production is still pending approval in Canada and the United States as of June 1990.

Raising a Cow's Milk Production

1. When a cow has a calf, she begins to produce a hormone called somatotropin. Somatotropin continues as long as she is milked.

2. In all mammals, the hormone somatotropin causes new mothers to produce milk for their offspring.

3. Scientists can gather somatotropin from the blood of cows with new calves, and are synthetically able to make it in laboratories.

4. If a milking cow receives extra somatotropin by injection, her production of milk will increase. Laboratory tests have produced increases as large as 30%, but the average increase is about 17%.

PROBLEM

Good day, Agent AgSci.

A part-time farmer needs your help. Your assignment is to ensure that his 50 ewes (female sheep) all have lambs in the same month next year.

Thank you for having volunteered.

T.

Synchronizing Lambing

1. Ewes (female sheep) will only mate with rams during a condition called estrous (or heat).

2. Estrous is started when the ewe begins to produce a hormone (body chemical) called PGF2.

3. If a ewe is injected with synthetic PGF2, she will enter estrous within 48 hours.

4. Lambs develop for 145 days between fertilization and birth.

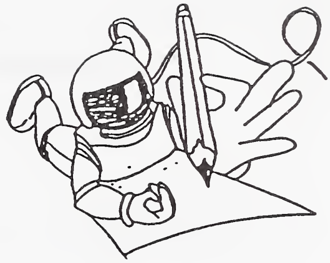
PROBLEM

Good day, Agent AgSci.

Your assignment today is to obtain 8 genetically identical bulls for an Alberta farmer. He believes that having the same genes will make the bulls similar in their behaviour, therefore more predictable and therefore safer.

Thank you for having volunteered.

T.



Embryo Separation

1. In the first part of its life, an embryo grows by having each cell form an exact duplicate of itself. Thus one cell becomes two, those two become four, those four become eight and so on.

2. Up to the 8-cell stage, cells that are separated from each other will develop as if they were separately fertilized ova.

3. Scientists have produced as many as four animals with identical genes from splitting a single 8-cell embryo.

4. Embryos cultured in a lab can be implanted into a cow which then acts as a surrogate mother.

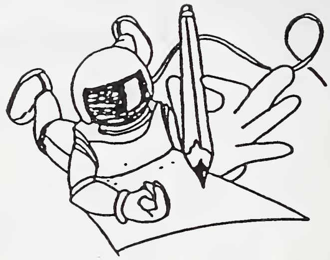
PROBLEM

Good day, Agent AgSci.

Alberta's wheat farmers cannot pay their fertilizer bills. Your assignment is to identify a way of increasing the supply of soil nitrogen to plants without using nitrogen fertilizer.

Thank you for having volunteered.

T.



Plant Breeding and Gene Transfer

1. Atmospheric nitrogen forms 78% of normal air, but is in a form that plants cannot use. Some soil organisms can convert atmospheric nitrogen into a form useful to plants.

2. Alfalfa, peas, clover and other legume plants form root nodules in which nitrogen-fixing bacteria called Rhizobium can live.

3. Adding Rhizobium bacteria to alfalfa pays back 30 times as well as adding nitrogen fertilizer.

4. If plant-breeding scientists can transfer the "root nodule" gene from alfalfa (or any of the legume family) into wheat embryos, then wheat plants could support their own Rhizobium colonies.

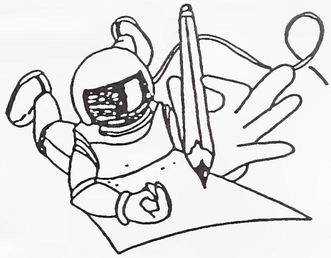
PROBLEM

Good day, Agent AgSci.

Your assignment for today is to arrange for some cattle to grow to full size without having their meat change from veal to beef.

Thank you for having volunteered.

T.



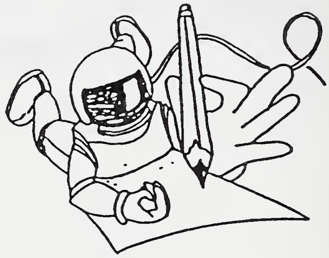
Increasing Yield of Veal Calves

1. The muscles of calves differ internally from the muscles in adult cattle. Calves' muscles yield veal, adult cattle muscles yield beef. Normally the muscles become adult in structure by the time a calf weighs 90 kg.

2. Some Piedmontese breed cattle have a gene called "double muscle" that causes their calves to be much larger than other breeds when their muscles change from veal-type to beef-type.

3. Scientists can produce animals with four parents instead of two by fusing two embryos together. The resulting animal is called a chimera (the "ch" is pronounced "k").

4. The chimera from fusing a Piedmontese embryo with a dairy breed embryo will remain calf-like in its muscle structure until it weighs 350 kg.



PROBLEM

Good day, Agent AgSci.

Your assignment is to ensure that next year Alberta's All Round Champion Cow (the AARCC) has 10 calves in the same month.

Thank you for having volunteered.

T.

Superovulation of Cows

1. The release of egg cells in cows is controlled by a hormone called FSH (follicle stimulating hormone).

2. A cow can be made to release several egg cells (ovulation) instead of her normal one by an injection of extra FSH.

3. A veterinarian can collect egg cells from a cow, fertilize them by artificial insemination and implant them into any mature cow.

4. Calves are born 275-290 days after fertilization.

Activity 2

SO, WHO CARES WHEN IT RAINS?

OBJECTIVE:	Students will observe how a growing cereal grain plant responds to different watering regimes.
CURRICULUM FIT:	**GRADE SEVEN - SCIENCE** ● Topic 1: Characteristics of Living Things **GRADE EIGHT - SCIENCE** ● Topic 5: Growing Plants ● Response of an organism to stimuli ● Appreciation of challenges faced by farmers
AGRICULTURE CONCEPTS:	Importance of soil and water
COGNITIVE LEVEL:	Application, Synthesis, Evaluation
MATERIALS REQUIRED:	Planting mix in trays or pots Distilled or aged water Fluid measuring apparatus Seeds of wheat, barley or oats
TIME REQUIRED:	20 minutes to set up experiment One minute every third day to water plants and record observations

BACKGROUND - For the Teacher

Responsiveness to stimuli is a basic characteristic of living things. Therefore it is a major field of study within the life sciences. It is also important at the production level of agriculture.

One key to a farmer's success is how well his crops respond to the stimuli they receive. In some cases, like egg production, pork production, or greenhouse production, the farmer can exert extensive control over what stimuli affect his crop. For other types of farming, like field crop production or cattle ranching, the farmer is only able to choose breeds or individuals that will likely respond productively to the stimuli they are most likely to receive.

In this lesson, your students will see how germinating grains respond to different amounts and schedules of watering. This should help them to understand why spring weather or water supply is so important to farmers.

PROCEDURE

Part 1
Preparation

1. Your students will work in groups of 4 or 5. Decide on the number of groups you will have and who will be in each.
2. For each group fill three trays or pots with planting mix.
3. Obtain a supply of seeds of one grain type and divide it so that each group will receive a similar amount.

Part 2
Introduction

4. Explain the set up and procedure of the experiment and tell the students that its results should show why rainfall patterns matter to farmers.
5. Assign the students to their working groups.

Part 3
The Activity

6. Have each group water the soil in one tray until it is saturated and draining from the bottom. This is Tray # 1. Do not water the other trays at this time.
7. Have students divide their seed grain into three sets.
8. When the watered tray stops dripping have students spread their seeds over the soil, rake the soil lightly to cover the seeds and lightly press the soil again.
9. Have students water a second tray until the soil surface is wet, but not until water begins to drain from the bottom. This is Tray # 2.
10. Each group must arrange to water Tray #1 and Tray #2 every third day, and to record changes in the trays daily. Watering should be enough to wet the top .5 mm of soil only.

Part 4
Conclusion

11. After two weeks students should be able to report:
    a) which grain sample germinated fastest.
    b) which grain sample produced the most plants.
12. Once the initial two weeks are finished, have students stop watering but continue to record changes in each tray.

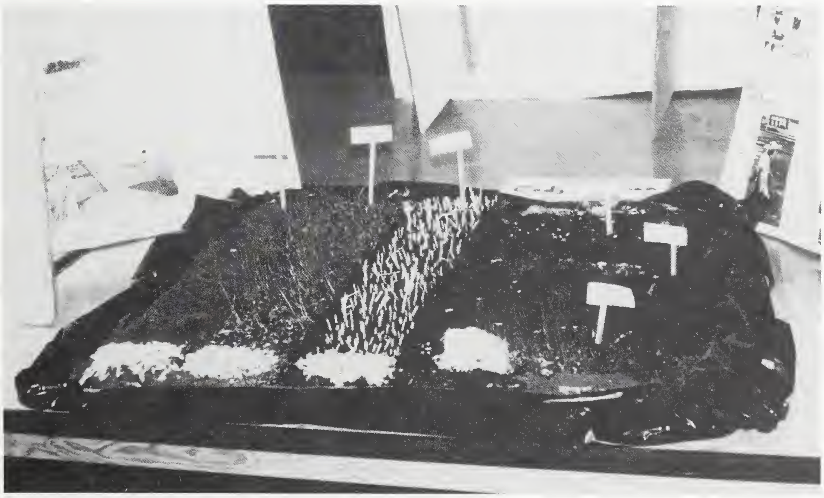
DISCUSSION QUESTIONS

1. Which watering regime was most favorable to the seeded grain?
2. Based on class results, speculate on the importance to grain farmers of
   a) soil moisture from melting snow.
   b) spring rains.
   c) summer rains.
3. What other weather factors are important to farmers?
4. Do different kinds of farmers need different kinds of weather?

RELATED ACTIVITIES

1. Interview a farm owner, implement dealer, or district agriculturist about the ideal weather for farms in your area.

Checking results of soil treatments.



An experiment to show plant response to fertilizer.

H.T. Coutts School
1987 Agricultural Fair
Claresholm, Alberta

Activity 3

WHY PASTEURIZE MILK?

OBJECTIVE: Students will determine the effect of pasteurization on microbial populations and shelf life of milk.

CURRICULUM FIT: **GRADE SEVEN - SCIENCE**

- Topic 5: Micro-organisms and Food Supplies
- Role of micro-organisms in food spoilage
- Technologies for preparing, preserving and protecting human food
- Safety standards for preparing and handling food

AGRICULTURE CONCEPTS: Technology and capital intensity
Production, processing and marketing system

COGNITIVE LEVEL: Application, Analysis

MATERIALS REQUIRED:

- unpasteurized milk
- 1 ml glass pipettes with 1/10 ml graduations (60 autoclavable or 200 disposable)
- enamel cooking pot
- Bunsen burner
- 50 pre-poured nutrient agar in petri dishes
- sterilized test tubes and test tube holder
- pH meter and pH4 and pH7 solutions to calibrate pH meter
- 10 glass spreaders and 95% alcohol solution to sterilize spreader
- 1 litre boiled water or 0.1% peptone solution adjusted to pH 7
- thermometer

TIME REQUIRED: 2 full periods plus parts of 1 or 2 other periods

BACKGROUND - For the Teacher

The dairy is a modern processing plant where milk is tested for quality, processed and packaged before delivery to stores. The milk the tank truck delivers to the dairy is called raw milk. It has not yet been pasteurized and may contain harmful bacteria. Some bacteria found in raw milk may cause disease and illness in people who drink it. Other bacteria cause milk to spoil, reducing the time it can be stored. Therefore, all milk for sale in stores has been pasteurized.

Louis Pasteur, a famous French scientist, discovered in the 1860s that heating milk to 63°C for 30 minutes, then quickly cooling it to 4°C would kill harmful bacteria without changing the nutrient value of the milk. This process became known as pasteurization.

Today a much faster process is used by the dairies. This process is called High Temperature Short Time pasteurization (HTST) and involves heating the milk to a minimum of 72°C for 16 seconds.

There is an even faster process which produces milk that needs no refrigeration - it is sold by grocery stores in boxes stored on the shelf. This special method of pasteurization is called Ultra High Temperature (UHT) pasteurization. In this process, the milk is heated to a minimum of 130°C for 1 second then quickly cooled to 2°C. Because of this higher heat treatment, the milk is almost sterilized and doesn't need refrigeration until it has been opened. UHT milk has the longest shelf life.

In this lesson, students will learn what pasteurization is, what pasteurization does, and the effect pasteurization has on the bacteria count in milk and on shelf life. If you have access to a pH meter, you can show the effects of bacteria on the quality of pasteurized milk. Because milk is a good buffer, it takes a long time for the pH to change, even in an unpasteurized milk sample. By leaving the milk at room temperature for 48 - 72 hours, however, the deterioration process increases rapidly and students should be able to see that the unpasteurized sample has undergone a greater drop in pH than the pasteurized sample. This more extreme development of acid conditions indicates greater bacterial action.

PROCEDURE

Part 1
Demonstration

1. Set two identical, cleaned beakers at the front of the class and mark them 1 and 2.
2. Add 250 ml of pasteurized milk to beaker 1 and 250 ml of unpasteurized milk to beaker 2.
3. Test each milk sample for pH and record results as STARTING pH. A pH of 0 to 7 is acid, a pH of 7 is neutral and a pH over 7 to 14 is alkaline.
4. Explain to the students that the two samples will be left at room temperature for the next three days, and that you will test for pH at 24, 48 and 72 hours. If necessary, adjust these times to fit your class schedule.
5. Ask your students to predict the results.

Part 2
Preparation

6. Divide the class into working groups of three.
7. Set up the pasteurization apparatus: either a large pressure cooker or a water bath with several wire test tube racks.
8. Boil 1 litre water or prepare 1 litre of 0.1% peptone solution for students to use diluting milk.
9. Prepare four petri dishes with sterile nutrient agar for each working group.

Part 3
Introduction

10. Explain pasteurization briefly.
11. Describe the experiment and its meaning.
12. Rearrange the students into their work groups and distribute the group apparatus.

Part 4
Student Experiment

13. The students will be pasteurizing a sample of raw milk and comparing bacterial growth in this pasteurized milk with raw milk.

Identification

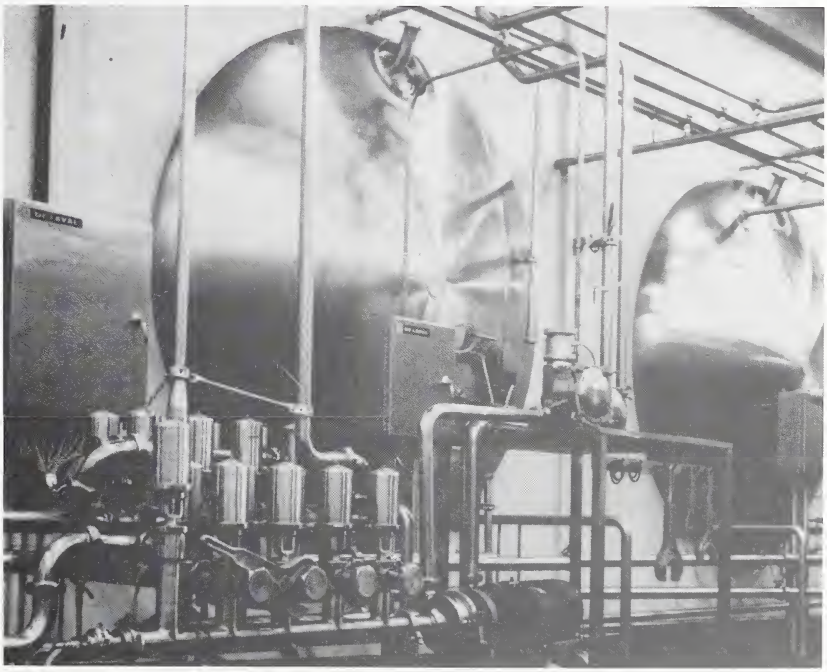
14. Each group must label their test tubes and petri dishes with their group name. They should also number their petri dishes 1 - 4.
15. Add 5 ml of raw milk to each of two test tubes.

Pasteurization

16. Place one test tube in the pasteurizing apparatus. (Use either a pressure cooker at 15 psi for 15 minutes or an open water bath at 63°C for 30 minutes.)

Dilution

17. Number two beakers; add 99 ml of boiled water to #1 and 9 ml of boiled water to #2.
18. With a sterile graduated pipette, draw 1 ml of raw milk from the second test tube and add it to Beaker #1. The use of a pipette is relatively simple. Suck up the milk to a certain point, taking care not to get it into the mouth. Then, stopper the upper end of the pipette with the index finger. By regulating finger pressure, the level of liquid is allowed to fall to the required mark. Wipe away excess liquid on the outside of the pipette before draining it into the beaker. Gently blow through the pipette to force out the last drop of milk.
19. Shake Beaker #1 well to mix solution.
20. <u>Use a new pipette</u> to remove 1 ml of the diluted milk in Beaker #1 and add it to Beaker #2.



Industrial-size pasteurizing vats.

Transfer and Spreading	21. Use another new pipette to transfer 1 ml of the 1:100 dilution liquid to petri dish #1. a) Lift the petri dish cover just high enough to insert the pipette. b) Hold the pipette at a 45° angle, touching the dish side above the agar. c) Do not blow on the pipette. d) Close dish cover immediately. 22. Repeat the steps immediately above with a fourth pipette to transfer 1 ml of the 1:1000 fluid to petri dish #2. 23. Use a sterilized glass spreader to spread the diluted milk evenly across the agar surface. a) Rinse the spreader in 95% alcohol solution after each culture is spread. b) Close lid immediately after spreading and tape it shut.
Repetition	24. When the pasteurized milk is ready, repeat the dilution, transfer and spreading procedure for the cooled, pasteurized milk. Use beakers #3 and #4, dishes #3 and #4, and sterile pipettes at each stage.

NOTE
These procedures are summarized in the diagram that follows.

Incubation	25. Invert petri dishes and leave at room temperature. 26. On the second day, check the pH of the two milk samples you established at the start of the experiment. Have the students record the results. 27. Check the milk samples again on Day 3 and record the results. 28. On Day 3, students should also inspect their petri dishes (48 hour count). Have them hold each one up to a light source and count all the opaque spots, even those that are only pinpoint size. This count should be repeated the next day (72 hour count), but if that is impossible then put the petri dishes in a refrigerator at about 4°C to slow development until colonies can be counted.
Part 5 Conclusion	29. Compile the results of the plate counts. Compare the average counts of pasteurized and raw samples at each time period. How does pasteurization affect bacterial growth in milk? 30. Based on the demonstration, how does pasteurization affect souring of milk?

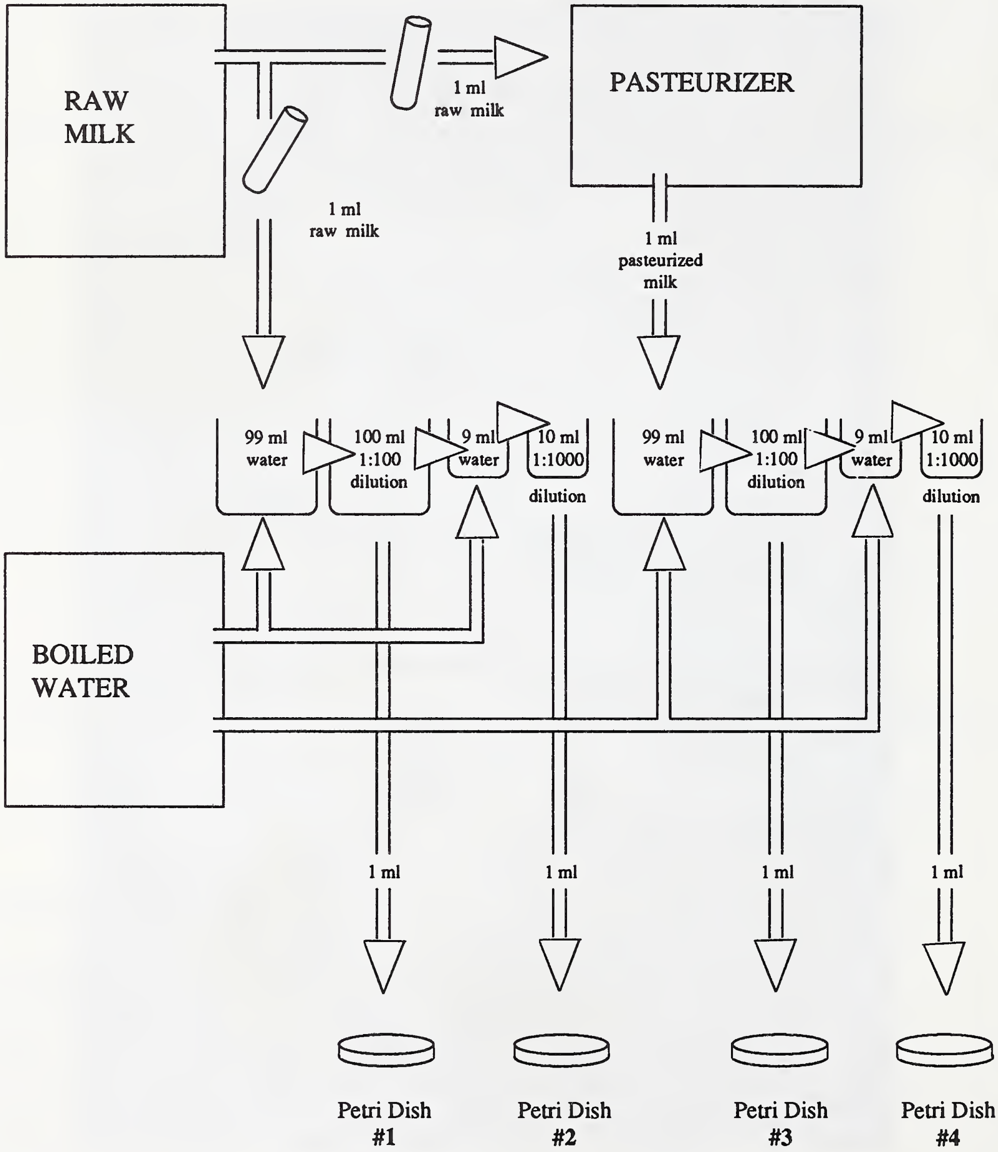
DISCUSSION QUESTIONS

1. Define pasteurization/sterilization.
2. In what way(s) are bacteria harmful/beneficial to us?
3. Why does UHT milk not require refrigeration when stored?
4. Is there a difference in taste between normally pasteurized (HTST) milk and UHT milk? (perform taste test) Why?
5. What factors influence the souring of milk?
6. What is the total count of bacteria in the original sample of raw milk (undiluted) if you counted 200 colonies on the plate containing 0.001 ml of the sample of raw milk?
7. Why must we be so careful to use clean glassware when transferring solutions?

RELATED ACTIVITIES

1. Research the work of Louis Pasteur.
2. Invite a speaker from the Board of Health to talk about pasteurization and other food purifying practices.

DILUTION PROCEDURE



Activity 4

MOTHERS OF INVENTION

OBJECTIVE: Students will design, construct, test, and market a simple agricultural machine.

CURRICULUM FIT: **GRADE EIGHT - SCIENCE**

- Topic 2: Energy and Machines
- Applications of mechanical systems
- Inventing a device that makes efficient use of energy
- Technology is concerned with the solution of practical problems

AGRICULTURE CONCEPTS: Technology and capital intensity
Production, processing and marketing system

COGNITIVE LEVEL: Application, Synthesis, Evaluation

MATERIALS REQUIRED: Frozen corn on the cob (1 cob per student or 1 per group)

TIME REQUIRED: 1 - 3 periods additional student independent time might be needed.

BACKGROUND - For the Teacher

Machines are devices for doing work. Modern food producers and processors use many large and complex machines to keep up with global food requirements. To develop these machines the agricultural industry relies on scientific research and technology.

Past agricultural inventions arose out of a need to solve problems and usually involved much trial and error. History shows that solving one problem often leads to new problems. Therefore, criteria beyond speeding up a job must be made for an invention to be accepted. Some of these criteria cannot be satisfied. A successful invention is one which meets the most criteria, including those that are of major concern at the time.

In this lesson students are to design, construct, test and market a simple agricultural machine. This experience will require them to act as scientists, experiencing the process of inventing. As they work, your students must keep in mind the criteria or guidelines necessary for their invention to be accepted. They may discover that not all of these criteria can be met completely.

This activity will probably be most successful if you introduce it when your students have just finished their unit on the six simple machines: levers, pulleys, wheel and axle assemblies, inclined planes, wedge and screws. They can include any combination of these to multiply the forces acting on the corn.

PROCEDURE

Part 1
Introduction

1. Ask students for examples of past inventions. Do these inventions have elements in common?
2. Have the class make a list of criteria which an invention must meet.
3. Once the class has developed a set of criteria for evaluation you can show the corn cobs and present the problem: To invent a machine that will get the kernels off the cob without damaging them.

Part 2
The Activity

4. Students can work alone or in groups preparing a "blueprint" (eg. sketches of corn and "de-kernelizer", materials needed, procedures in construction invention, testing methods, etc.)
5. Once the students have developed a workable idea, they should construct their corn "de-kernelizer" for display to the class.

Part 3
Conclusion

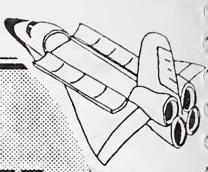
6. When all students (or groups) have demonstrated their machines, they should each rate all entries against the criteria established earlier.

DISCUSSION QUESTIONS

1. How do inventions come about?
2. Does the invention meet all, some, or any of the list of criteria?
3. Do some criteria conflict with others?
4. Which inventions used the principles you were taught in the Machines and Mechanics Units? How?
5. Could an invention be improved? How?
6. Do inventions ever change over time? Why? Examples?

RELATED ACTIVITIES

1. Invent an agricultural device which will:
   a) draw milk out of a rubber glove
   b) automatically "irrigate" a flower pot at a specified time
   c) de-skin a potato leaving no marks
   d) thresh wheat



RATE YOUR INVENTION WITH THESE CRITERIA

Ease of operation

Safety

Manpower needed

Adaptability to surroundings

Efficiency (time requirements)

Appearance

Availability

Cost

Waste control

Noise control

Damage to surroundings

Durability

Activity 5

THE HUMAN INCINERATOR

OBJECTIVE: Students identify all of the food and non-food substances that they ingest in a week and trace them back to their original sources. They then develop a web to display these results.

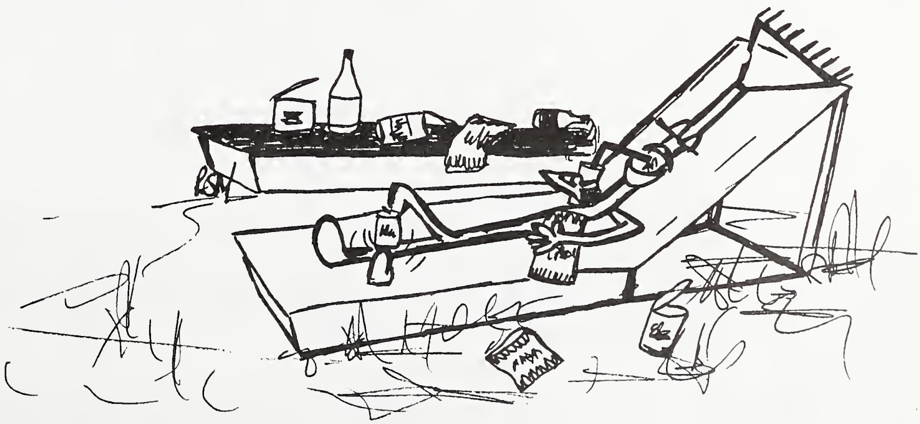
CURRICULUM FIT: **GRADE EIGHT - SCIENCE**
- Topic 3: Consumer Product Testing
- Consumer product characteristics and composition
- Researching skills

AGRICULTURE CONCEPTS: Technology and capital intensity
Production, processing and marketing systems

COGNITIVE LEVEL: Analysis

MATERIALS REQUIRED: Large copy of the Human Incinerator Ingestion Web

TIME REQUIRED: 1 - 2 periods



BACKGROUND - For the Teacher

Many food items are processed before being sold to us. Processed foods can be broadly defined as those foods that have been modified in some way after being produced or harvested. For instance, food may be enriched by the addition of nutrients (like vitamins or amino acids). Additives, such as preservatives and artificial colors, may also be put into foods. Some examples of processed foods include pasteurized milk, cured meat and canned fruits. To the food market, processed food means better looking, smelling and tasting food, and a longer shelf life — all of which means greater profitability. To the consumer, processed food offers convenience and speed in preparation.

Modern science is also capable of producing synthetic foods, which resemble natural foods, and of remaking natural substances into an entirely different form. These products are known as fabricated foods. An example is the creation of vegetable protein meat analogues as a substitute for meat cuts.

Throughout their work on this lesson, students will first come to recognize the variety of things that they ingest. As they continue, they will see the sources of these substances and the processes by which the substances reach them.

PROCEDURE

Part 1
Preparation

1. One week prior to this lesson, hand out a copy of the Human Incinerator Ingestion Web and have each student fill out the branches with all that they ingest throughout the week.

Part 2
Introduction

2. Using the overhead projector or workboard, draw a composite Ingestion Web, filling out the branches using food and non-food substances the students have ingested over the past week.

Part 3
The Activity

3. Classify a few substances according to the four basic food groups: milk and milk products; breads and cereals; fruits and vegetables; and, meat, fish and poultry. Some substances will not fit in any of the food groups. Leave these substances for the students to research on their own later.
4. Identify the ingredients in a few substances ingested. This again will involve research for the more difficult substances and students will do this later.
5. Identify the origin (land, sea, laboratory, etc.) of a few substances and categorize them as unprocessed foods, processed foods or non-foods. Processed foods can be further categorized as being fabricated, being enriched or having additives. Use the background information and glossary to define each of these categories for the students. They will use the definitions to classify a substance they choose from the classroom web.
6. Have the students choose one substance from the classroom web which has not been classified and create a chain for it showing the steps involved from its origin to its ultimate processor . . . themselves. They might have to use the library at this point.
7. Have the students chart their findings in a format along the lines of the attached Human Incinerator Table.

Part 4
Conclusion

8. Using the overhead projector or blackboard, complete the Human Incinerator Table using the food and non-food substances your students chose in step 6.

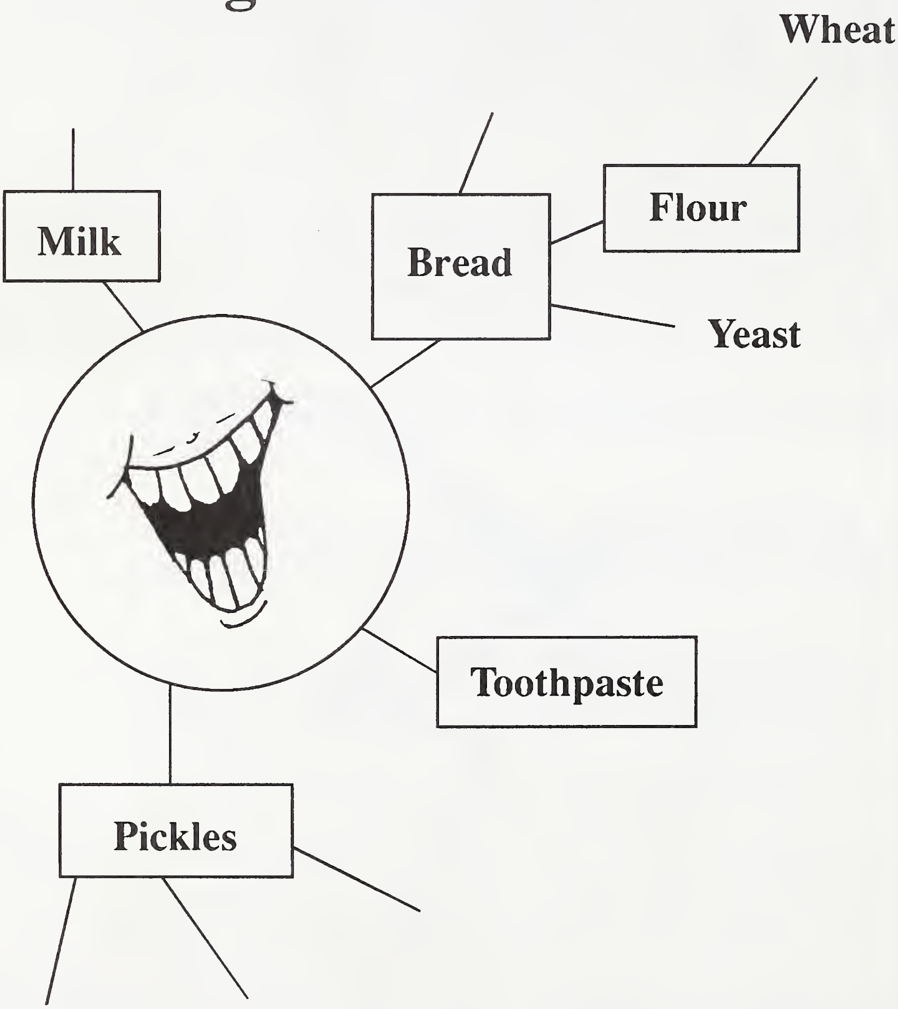
DISCUSSION QUESTIONS

1. What is the original source of the substance (i.e. land, ocean, lab.)?
2. If land is a primary source, did the item come from a domesticated plant/animal or a wild plant/animal?
3. What are some of the consequences of domestication (eg. on prices, energy use, plant and animals, environment)?
4. How many steps did the item undergo before reaching your mouth?
5. Did the item come from Alberta? Canada? Outside of Canada?
6. If the item came from Alberta, is it grown locally?
7. What item cost more? One from the land, ocean or lab? Why?
8. Did the item come directly from a plant or an animal? If not, then where did it come from?
9. What is the purpose of food processing?
10. What is the difference between food additives and food enrichment?
11. Should food be processed? What are the pros/cons?

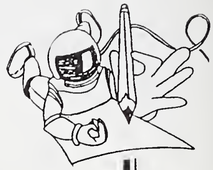
RELATED ACTIVITIES

1. Have students bring food labels and list some additives in common foods. Most prepackaged food products sold in Canada must carry a list of ingredients in descending order of proportion. Additives, if there are any, are generally found at the end of the list. The Health Protection Branch of Health and Welfare Canada controls the use of food additives. There are about 350 or so food additives on the market. As part of this assignment, students can try to obtain additional food additive information from Health and Welfare Canada.

Example of Human Incinerator Ingestion Web



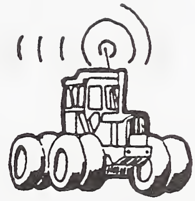
Human Incinerator Ingestion Web



Human Incinerator Table

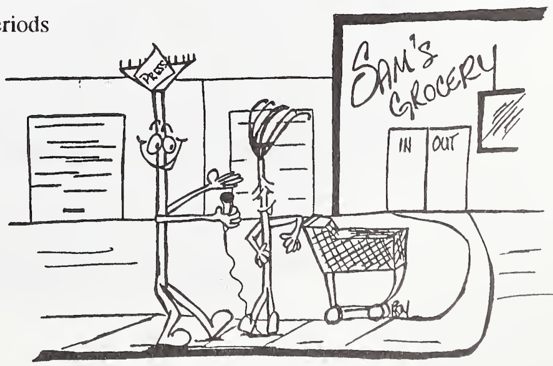
Substance	Basic Food Group	Ingredients	Origin	Category	# of Steps Involved

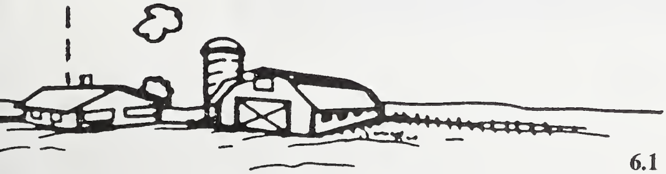
Activity 6



CONSUMER REPORT

OBJECTIVE:	Students will perform various quality tests on different brands of bread in order to write a "consumer report".
CURRICULUM FIT:	**GRADE EIGHT - SCIENCE** ● Topic 3: Consumer Product Testing ● Standards for product composition, packaging, labelling and advertising
AGRICULTURE CONCEPTS:	Technology and capital intensity Production, processing and marketing systems
COGNITIVE LEVEL:	Analysis, Evaluation
MATERIALS REQUIRED:	**Main Activity** - loaves of bread from as many different companies as possible - weight scale - height scale or ruler - bread knife - several butter knives **Optional Activity** - Bunsen burner - bread samples - distilled water - 6M (dilute) sulfuric acid - 95% ethanol (ethyl alcohol) - 250 ml glass beakers (2) - test tubes (2) - glass rod or spatula
TIME REQUIRED:	1 - 2 periods





BACKGROUND - For the Teacher

What goes into bread? Typical ingredients include flour (54%), water (37%), yeast (3%), whey milk powder (2%), shortening (1%), salt (1%), sugar (1%), vitamin and iron (0.5%) and calcium propionate (0.5%). Variation from these proportions alters such things as shape, color, shelf-life (mold growth), aroma, texture, weight, size and taste.

All of these characteristics are important: to the Health Protection branch of Health and Welfare Canada for food safety, to the processor and retailer for sales, and to you the consumer for appearance, taste and safety. That is why standards are set and tests performed to ensure the maintenance of those standards.

In Activity A of this lesson, students will perform quality tests on several different brands of bread. In so doing, they will gain first-hand experience with the standards a bread must meet to be sold to consumers. From the tests, students will rate the breads tested, identify those which meet the standards and those that do not, and make recommendations concerning the best kind of bread for specific situations.

Note that you must compare different brands of the same type of bread (e.g. white, brown, 60% whole wheat). If you test more than one type of bread, then each type comparison is a separate test.

Activity B is optional. It is a chemical test for the chemical mold-inhibitor, calcium propionate. Calcium propionate is added to bread to enhance its keeping quality and stability so that it may be transported long distances and stored safely.

Preservatives like calcium propionate are regulated by the Health Protection Branch of Health and Welfare Canada under the Food and Drugs Act. Bread claiming to have no preservatives contains no artificial preservatives. It does, however, contain natural preservatives, like raisin juice concentrate.

PROCEDURE

Activity A

Part 1
Preparation

1. On the first day of the activity, make a set of Quality Score Sheets for each loaf.
2. Transfer your loaves from their brand packages into clear plastic packages identified by number.
3. Record the number of each loaf on both packages so you will know which brand each loaf is.

Part 2
Introduction

4. Explain the importance of quality control and quality testing to food safety and to consumer acceptance.
5. Describe the tests that students are to perform, and what they will learn from their results.

Part 3
The Activity

6. Divide your class into as many groups as there are loaves.
7. Give each group a loaf without disclosing the brand-name.
8. Give each group a copy of the Bread Quality Score Sheet and allow them to perform each test on their mystery loaf.

NOTE
Emphasize to your students that this is not a competition - although they are working in groups, they are one team attempting to find the loaf or loaves which meet(s) each standard best. Therefore, they must be as objective as possible in their evaluation.

Part 4

Conclusion

9. On the second day, have each group describe their results, including individual test scores, and the total test score.
10. Rank the loaves, according to total test score on the blackboard.
11. Finally, reveal the brand name of each loaf for your students.

DISCUSSION QUESTIONS

1. Which brand produced the best sample of bread? The worst?
2. What is the difference between subjective and objective evaluation? What type of evaluation did you perform?
3. Why is it valuable to test a sample without knowing its brand name?
4. For each of the ten quality tests you performed on bread, give a reason why the characteristic is important. Are there other characteristics?

Bread moving from the oven to a slicer/wrapper.

PROCEDURE

Activity B (Optional)

Testing for presence of calcium propionate (mold inhibitor).

1. Obtain 2 slices of bread; one slice which has calcium propionate in it and the other slice which does not. Do not let your students know which is which.
2. Place each slice in a 250 ml beaker and add 100 ml of distilled water to each. Stir the mixture with a glass rod or a spatula.
3. Drain off about 10 ml of the solution in each beaker into a test tube, holding back as much of the bread as possible with a spatula or glass rod.
4. Add 5 ml of 6M (dilute) sulfuric acid to each test tube. Watch for an immediate precipitate in one of the test tubes.

NOTE
Wear safety goggles when doing tests for chemical reactions.
If sulfuric acid comes in contact with the skin, flush immediately with water.

5. Add 4 ml of 95% ethanol to each test tube and heat the test tubes evenly. As the contents of the test tubes approach the boiling point, waft some of the vapors toward your nose and ask your students to come forward and do likewise. The strong odor of pineapple from one of the test tubes confirms the presence of calcium propionate.

Passing the taste test.

Loaf Number:

Bread Quality Score Sheet

Test for: Outward Appearance

Declared Weight: ____________________

Specified Height: ____________________

CHARACTERISTICS	PERFECT SCORE	YOUR SCORE	STANDARD
Shape	10		Take one slice from each end of the loaf (count in 5 slices on both sides). Lose 5 points if slices do not match. Lose another 5 points if loaf is caved in.
Color	10		Hold a slice up to a light source. Lose 5 points in the color is not uniform throughout the slice. Lose another 5 points if the crust is burned.
Character of Crust	10		Examine crust for crushed appearance. Lose 5 points if crushed. Lose another 5 points if crust is difficult to tear.
TOTAL	30		

Loaf Number: ☐

Bread Quality Score Sheet

Test for: Volume

Declared Weight: ______________________

Specified Height: ______________________

CHARACTERISTICS	PERFECT SCORE	YOUR SCORE	STANDARD
Weight variance	10		Actual weight must be within ± 7g of declared weight - lose 3 points for every 7g outside this.
Height variance	10		Actual height must be within ± 1.25 cm of specified height. Lose 3 points for every 0.5 cm outside this (N.B. measure from the highest point of the loaf.)
Moisture Content	10		Actual moisture content must be within 1% of declared moisture content (37%). Lose 3 points for every 1% over 38%. Weigh the loaf to the nearest 0.1 g (A). Cut the loaf into 2-3 mm slices, spread on paper and allow to dry in a warm room overnight so that the bread is crisp and brittle. Re-weigh the loaf on the same balance to the nearest 0.1 g(B). Calculate the percent moisture as follows: $\% \text{ Moisture} = \frac{A - B}{A} \times 100$
TOTAL	30		

Loaf Number: ☐

Bread Quality Score Sheet

Test for: Interior Quality

Declared Weight: ____________________

Specified Height: ____________________

CHARACTERISTICS	PERFECT SCORE	YOUR SCORE	STANDARD
Grain	10		Hold a slice up to a light source. Lose 5 points if holes extend through slice (you will be able to see through the slice). Lose another 5 points if tunnels are present (very large holes).
Texture	10		Hold a slice up to the tip of your nose. Move it around. Lose 5 points if it feels rough (it should feel like crushed velvet). Draw a knife across a slice as if you were spreading peanut butter (firm). Lose another 5 points if slice rips.
Aroma	5		Imagine a slice as a handkerchief. Hold a slice up to your nose snugly, open your mouth and breathe deeply. Score out of 5 points.
TOTAL	25		

Loaf Number:

Bread Quality Score Sheet

Test for: Taste Quality

Declared Weight: ____________________

Specified Height: ____________________

CHARACTERISTICS	PERFECT SCORE	YOUR SCORE	STANDARD
Crust	10		Taste a sample of crust. Lose 5 points if crust tastes rancid or burned. Lose another 5 points if crust is very difficult to chew.
Grain	5		Taste a sample of grain (the inside of the bread). Lose another 5 points if grain is flat-tasting (usually the case if the loaf has many holes/tunnels).
TOTAL	15		

Evaluation of Score

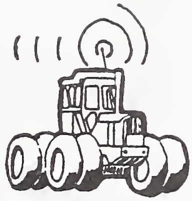
CATEGORIES	TOTAL PERFECT SCORE	TOTAL YOUR SCORE
Outward Appearance	30	
Volume	30	
Interior Quality	25	
Taste Quality	15	
GRAND TOTAL	100	

SCORING

95 - 100	Excellent
85 - 95	Very Good
70 - 85	Good
50 - 70	Fair
0 - 50	Poor

Activity 7

SOIL AND SEEDLINGS



OBJECTIVE: Students will design a method or device to monitor seedling growth and use it to compare the effects of varying conditions on that growth.

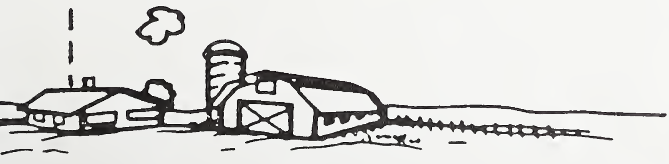
CURRICULUM FIT: GRADE EIGHT - SCIENCE
- Topic 5: Growing Plants
- Germination
- Growth patterns
- Soil nutrients and fertilizers

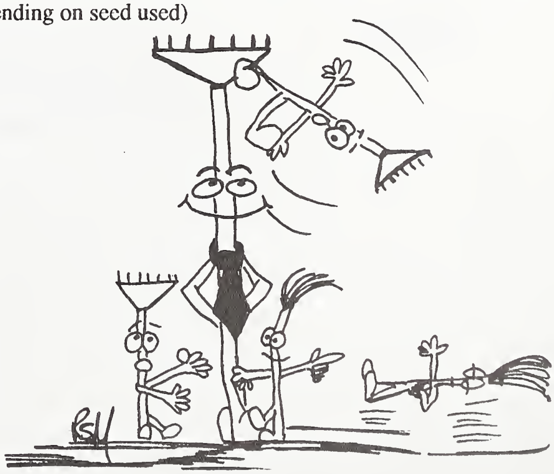
AGRICULTURE CONCEPTS: Importance of soil and water

COGNITIVE LEVEL: Analysis

MATERIALS REQUIRED:
Fast-growing seeds (eg. wheat, cucumbers, peas)
Fertilizer
Planting containers
Soil samples
Hydroponic solutions
Water
Lamps
pH solutions
Refrigerator
Earthworms
Peat moss

TIME REQUIRED: 1 - 2 full periods and parts of several others (depending on seed used)





BACKGROUND - For the Teacher

Dry seeds appear as lifeless as pebbles. They can be stored for weeks and months without showing signs of life. But as soon as one of these seeds is placed in a warm, moist place it swells, opens and develops gradually into a fully active plant. A young plant must do more than simply grow bigger; it must grow in such a way that it can take the best advantage of the light, water and other conditions available to it. Seedling growth is believed to be governed chiefly by hormones that are produced within the plant. The plant hormones (auxins, gibbercillins and cytokinins) are produced in response to environmental factors affecting the seedling.

In this lesson students investigate how varying environmental factors affect seedling growth. In doing so students, will use the scientific method.

The seeds chosen will have planting directions on their package. These directions should identify the ideal state of the major environmental factors affecting seedling growth. A set of seeds grown under these conditions should form the control group. Test groups can be established by varying each of the environmental factors.

You should also emphasize that ideal conditions for this particular seed are not necessarily ideal conditions for other seed species.

PROCEDURES

Part 1
Introduction

1. With your students, make a list of some environmental factors which they think affect plant growth. Without informing the students, use the instructions on the package of the seeds you have chosen as the basis for making the list of environmental factors.

Part 2
The Activity

2. Divide the class into groups of 2 or 3 depending on the number of factors to be tested and the class size.
3. Have each group choose an environmental factor from the list developed above and identify two different states of the factor. See attached list for examples.
4. Have each group set up an experiment in which seeds must grow under each alternative state of the chosen factors. The experiment should include a control where seeds are planted under ideal conditions.
5. Each group must design a monitoring method or device to keep a record of results over time.
6. Students must continue their experiments, for several days after the control seeds have sprouted.

Part 3
Conclusion

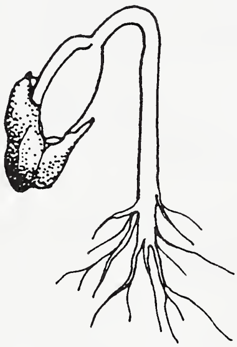
7. At the end, have groups present their experiments to the rest of the class, explaining their monitoring method or device and results.
8. With your students, list the ideal state of each environmental factor and compare their results with those on the seed package.

DISCUSSION QUESTIONS

1. Why is a control necessary in an experiment?
2. Which factors affect plant growth the most?
3. What is the independent variable in your experiment?
4. What variables are kept constant?
5. What are some variables that may be uncontrolled?
6. What is seed germination?
7. Could seeds germinate in outer space (where there is no air/gravity?)

RELATED ACTIVITIES

1. After ideal growth conditions have been determined for this particular seed, try using a variety of seed species under these conditions, showing the student that different plants have different needs.



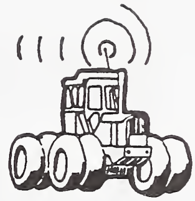
List of Environmental Factors That Affect Plant Growth

FACTOR	STATE 1	STATE 2	STATE 3	STATE 4
Soil	coarse sand	fine clay	none (hydroponic solution)	(control)
Light	window sill	cabinet drawer	fluorescent	
Water	add 100 ml daily	none added	add 500 ml daily	
Temperature	room temperature	refrigerator	heater	
pH	very acidic (2)	neutral (7)	very alkaline (10)	
Organic Matter Living Organisms	earthworms, soil, peat moss	soil, peat moss	sterilized soil alone	
Color of Surroundings	red	green	white	
Effect of Gravity (on seedling)	Pin seedling to a cork in a pan of water and cover with a metal can			
*Fertilizer	twice recommended amount	none added	half recommended amount	recommended amount

* Caution: handle with care - read and follow directions on package

Activity 8

LET IT GROW



OBJECTIVE: Students will grow new plants from cuttings of non-reproductive tissues from old plants.

CURRICULUM FIT: **GRADE EIGHT - SCIENCE**
- Topic 5: Growing Plants
- Plant propagation by vegetative reproduction (i.e. cuttings)

AGRICULTURE CONCEPTS: Importance of soil and water

COGNITIVE LEVEL: Comprehension, Application

MATERIALS REQUIRED:
- planting mixture (potting soil)
- plant pots or growing trays
- plants and plant cuttings
- geranium or other soft-stemmed house plant
- potato tuber
- top 1/2 inch of carrot roots
- pineapple tops
- willow or dogwood branches
- spider plant
- water
- rooting hormone (available at plant centres)

TIME REQUIRED: 20 - 40 minutes to take cuttings and plant them, 1 minute per day to water and record changes, one period to discuss results.

BACKGROUND - For the Teacher

Cloning is the developing of new individuals from the non-reproductive cells of an existing individual. In animals this procedure is very difficult as it requires that scientists decipher the process of cell specialization and determine ways to reverse it. These questions are unresolved to date.

Plant cells do not seem to present the same degree of irreversible specialization found in animals. As a result, cloning has been possible on a horticultural level for many years. The common methods of getting many copies of a single plant are called vegetative propagation. Root cuttings, stem cuttings, leaf cuttings and layering are common procedures. Vegetative propagation is more dependable than propagation by seed for certain plants (e.g. horseradishes) which do not produce enough seeds.

In this lesson, your students will grow a variety of new plants from old ones. In each variation, the process involves having cells of one type respecialize to develop organs (roots or stems or leaves) that were removed in taking the cutting.

PROCEDURE

Part 1
Introduction

1. Explain to students the relationship between vegetative reproduction and cloning.
2. Inform them that in this activity they will be developing clones of some sample plants by cutting off particular pieces and growing them.

Part 2
The Activity

3. Divide the class into groups of two or three.
4. Give each group a plant or source of cuttings and the matching propagation instructions from the following data sheets.
5. Each group is to make cuttings following their instruction sheet and to plant the cuttings in a pot or tray of growing mix.

> **NOTE**
> Results will occur sooner if students dip the cut end in rooting hormone.

6. Students will need to water their parts regularly, and should record changes daily.

Part 3
Conclusion

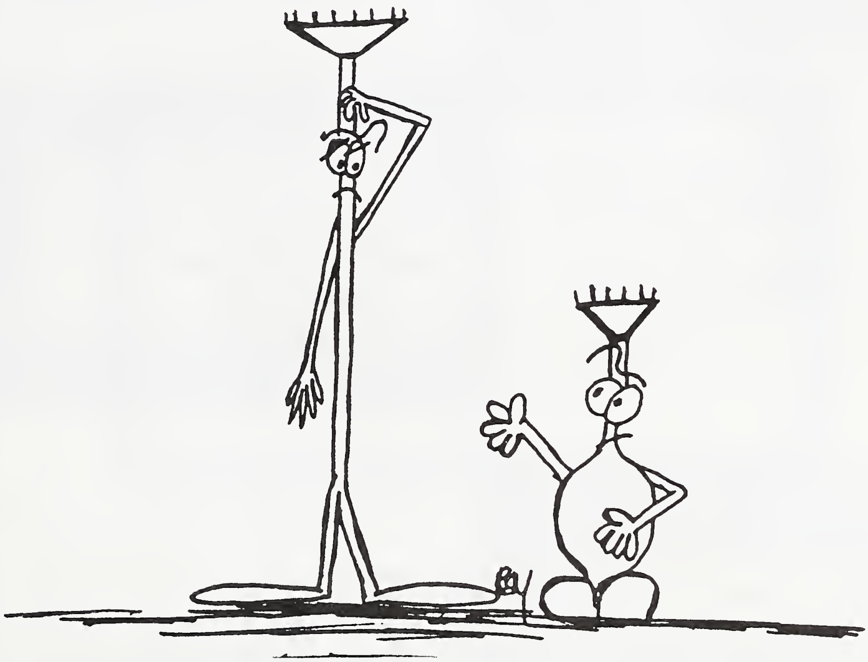
7. Have students report on how long their cuttings took to establish roots and how much they grew during the experiment.
8. Ask students to speculate on reasons why a farmer might prefer to establish a group of plants vegetatively instead of by seed.

DISCUSSION QUESTIONS

1. What are some common examples of plants that are grown vegetatively rather than from seed?
2. What are some advantages to a grower of having all plants identical?

RELATED ACTIVITIES

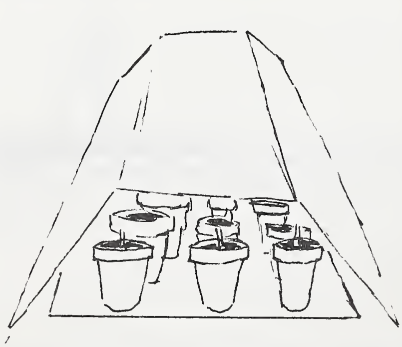
1. Develop a bulletin board display that illustrates various methods of propagating plants using vegetative methods.
2. Invite a horticulturalist, African violet grower, potato grower or other expert to demonstrate plant division and propagation to your class.



DATA SHEET ONE
Propagation Basics

Some plants will root in water. For example, ivy, impatiens, willow (sometimes) and many of the soft stemmed house plants.

Most plants will root more strongly in a moistened mix of ½ peat moss and ½ coarse sand, vermiculite or perlite.



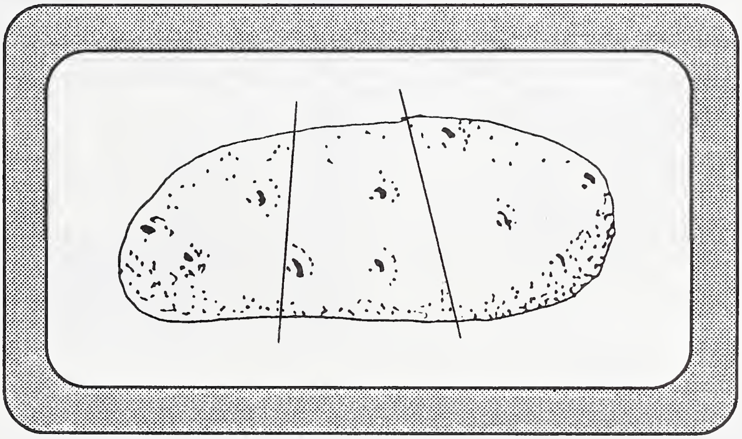
All plants but cacti will root most easily if they are regularly sprayed with water and protected from evaporation by a plastic sheet.

Dipping the lower end of a cutting in rooting hormone will speed up rooting.

DATA SHEET TWO
Propagation with Tubers

Tubers are fleshy underground roots or stems that some plants develop to survive harsh conditions. Potatoes are the food crop most commonly grown this way.

Cut a potato into several pieces, making certain that each piece includes 2 or 3 eyes.



WHAT TO DO

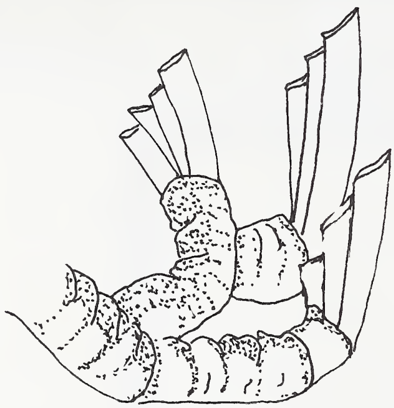
1. Push each piece into the rooting mixture and cover lightly.

2. Press down while still dry.

3. Water regularly until leaves appear above the soil.

DATA SHEET THREE
Divisions

Besides tubers, plants produce other base or underground structures that can be divided so that a new plant will grow from each one.

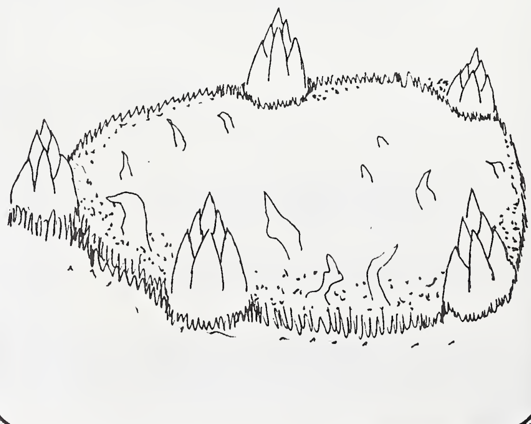


RHIZOMES - underground stems with growth nodes that will produce new plants.

Examples: iris, Lily of the Valley, and quackgrass.

CROWNS - small plants, buds or shoots that grow around the base of parent plant.

Examples: rhubarb, ferns.

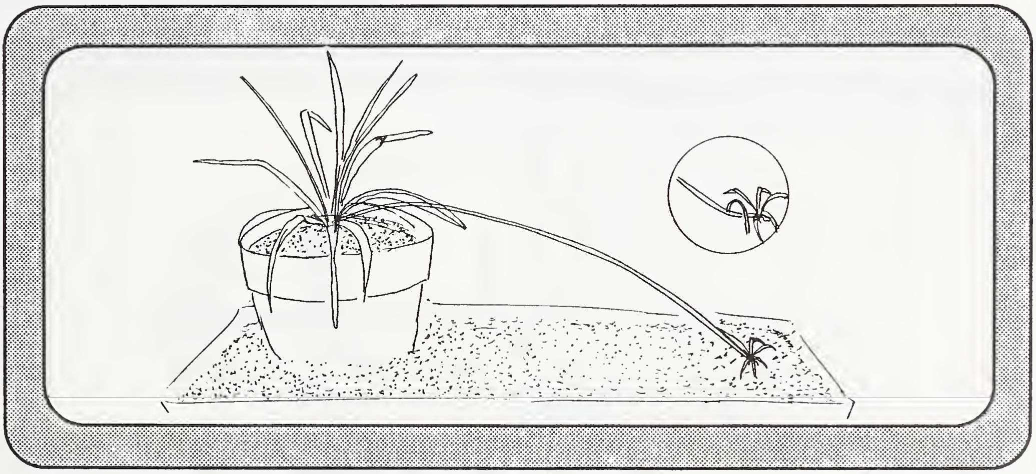


DATA SHEET FOUR
Runners and Offsets

Many plants produce a long leafless stem called a runner which grows a complete new plant called an offset at its end.

One well-known plant that produces runners is the strawberry. A strawberry grower, besides gathering berries, must choose some offsets to root every year to replace old plants.

The spider plant is used here because it is easier to work with.



WHAT TO DO

1. Place a potted spider plant in the center of a tray of rooting mixture.

2. Use an opened paper clip to pin offsets into the mix.

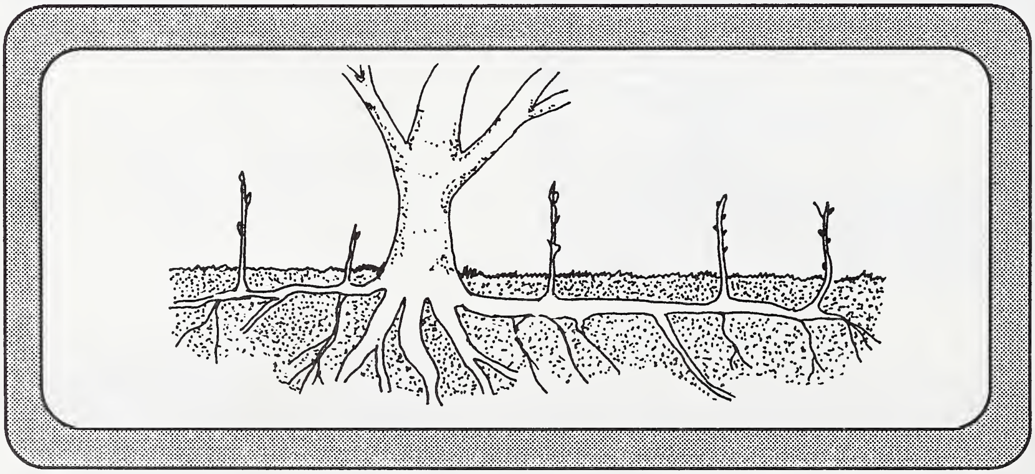
3. When your offsets are clearly rooted (expect about two weeks) cut them away from the large plant and establish them in their own pots.

DATA SHEET FIVE
Root Suckers

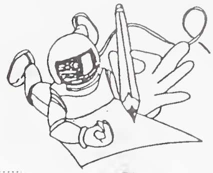
Some plants develop growth points on their roots.

New, offspring plants can grow from these root suckers.

Raspberries and saskatoons are the main food crops that reproduce this way. Lilacs, poplars, willows and wild roses also produce root suckers.



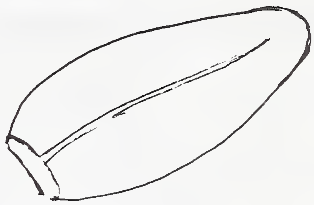
To reproduce plants from suckers, dig them up during the dormant period and transplant them.



DATA SHEET SIX
Leaf Cuttings

Many soft-stemmed plants can be reproduced from single leaves or a leaf and its stalk. This technique is commonly used for house plants.

Leaf blade cuttings - used especially for cacti and succulents. Let the cut end of the leaf dry before planting. Water sparingly.



Leaf petiole cuttings - used for geraniums, African violets and other potted plants. Remove the leaf plus about 3 cm of its stalk (petiole) and place in water or rooting mixture.

Leaf-bud cuttings - used for rubber trees, hibiscus and most other woody plants. Cut the leaf, its stalk, and a bit of stem including the bud where the petiole meets the stem (axial bud).

DATA SHEET SEVEN
Stem Cuttings

Woody, perennial plants are usually propagated by cutting pieces of stem with the leaves attached. These are dipped in rooting hormone and stuck into a coarse planting mixture which must be kept well-watered. There are two major types of stem cuttings:

Hardwood Cuttings

Taken during the dormant season from mature growth

Stored through winter for planting in spring

Should be 6 - 12 mm in diameter, long enough to have 3 or more buds

Poplar, Willow Alder, Dogwood

Softwood Cuttings

Taken in late spring or early summer from new growth

Should be gathered in early morning or on a rainy day

Take about 10 cm at the growing tip of the branch

Remove lower leaves before planting

Clematis, Apple, Rose, Dogwood, Willow

Activity 9

SASKATOON PIE

OBJECTIVE: Students will develop a strategy for domesticating a wild plant that produces edible fruit.

CURRICULUM FIT: **GRADE EIGHT - SCIENCE**

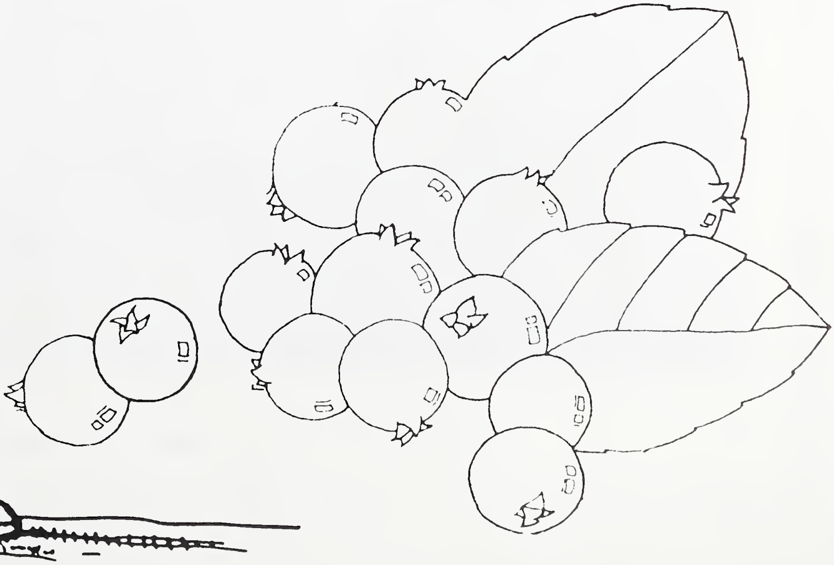
- Topic 5: Growing Plants
- Plant propagation by vegetative reproduction
- Flowering and seeds
- Specialized varieties, plant breeding
- Awareness that agricultural plant varieties are usually the product of intensive breeding

AGRICULTURE CONCEPTS: Diversity of the industry
Technology and Capital Intensity

COGNITIVE LEVEL: Synthesis, Application

MATERIALS REQUIRED: Information about saskatoons (included)

TIME REQUIRED: One 40 minute period



BACKGROUND - For the Teacher

Agricultural research covers a variety of topics, most of which aim at improving an existing crop, developing new uses for a crop or finding better ways to process a crop. Another important type of research is the search for completely new crops.

The saskatoon (Amelanchier alnifolia) or serviceberry is a common wild plant throughout Alberta. Because its fruit is widely popular, it has become the subject of research aimed at developing it into a bush fruit orchard crop.

Early research focused on selective breeding from wild stock to develop domestic varieties with particular characteristics. Several varieties are now available.

A new stage of research, still in progress, is to use cloning and propagation techniques to develop bushes that are so similar genetically that an entire orchard could be expected to ripen at once. This short harvest season is essential to an economically sensible orchard.

In this lesson, your students are asked to design a scientific program to domesticate the saskatoon. Using selective breeding and cross- breeding techniques, or propagation techniques, they will recommend a strategy for attacking this problem.

PROCEDURE

Part 1
Introduction

1. Explain to the class how selective breeding can exaggerate certain characteristics.
2. Review the propagation techniques covered in Activity 8.

Part 2
The Activity

3. Divide the class into working groups of four or five.
4. Tell the groups that you have a wild fruit plant, the saskatoon, which you want to domesticate so that farmers can grow it in orchards.
5. Ask each group to list the steps they would take to:
   a) produce dependable bushes from wild plants, and
   b) develop cloned bushes for regular cropping.

Part 3
Conclusion

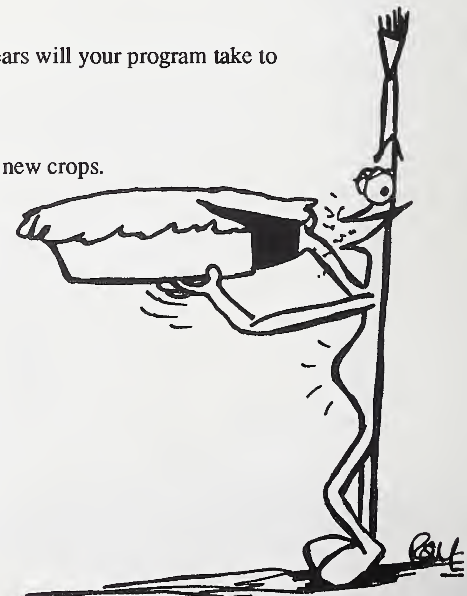
6. Each group is to present their research program to the rest of the class.

DISCUSSION QUESTIONS

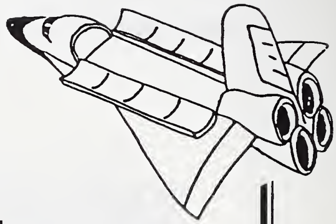
1. Based on the information on the Saskatoon Berry Facts Sheet, how many years will your program take to complete?
2. Are there any ways we can speed up this process?
3. What are some ways to use saskatoons?
4. What are some other wild Alberta plants that could be domesticated to give new crops.

RELATED ACTIVITIES

1. Invite a speaker to describe modern plant breeding techniques.
2. Bring in wild plant products that could be used for new crops.



Saskatoons - your product of the future.



DATA SHEET ONE
Saskatoon Berry Facts

A native shrub, 4-5 m tall.

Most successfully grown from seed. Seeds must be separated from the fruit, scratched with sandpaper and stored in damp peat moss at 2 - 7°C for 90 days to ensure germination.

Vegetative propagation has shown limited success by means of suckers, root cuttings and soft wood cuttings. These are all more difficult than growing from seed.

The shrub has a long juvenile phase: it takes 6 years to produce any fruit and 8 years to reach full production.

Orchard plants must be irrigated in case of drought and have well draining soil during wet years.

Activity 10

DIRTY BUSINESS

OBJECTIVE: Students will learn how soil texture affects plant growth by performing settling tests, porosity tests, and seed growth tests.

CURRICULUM FIT: GRADE EIGHT - SCIENCE

- Topic 5: Growing Plants
- Topic 6: Interactions and Environments
- Germination
- Soil components and nutrients
- Abiotic factors in the environment

AGRICULTURE CONCEPTS: Importance of soil and water

COGNITIVE LEVEL: Analysis

MATERIALS REQUIRED:

- soil samples collected from different locations (a shovelful of each sample)
- 100 ml graduated cylinders
- water
- large waste basket (water proof)
- paper towels
- transparent, plastic, cling wrap
- plastic 1 litre bottles
- cloth 1 m2 for use as filters
- rubber bands
- scissors
- hacksaw
- 500 ml beakers
- fast growing seeds (grain seeds, cucumbers, peas or beans)
- 3-inch plant pots

TIME REQUIRED: 2 - 3 periods

BACKGROUND - For the Teacher

Soil consists of two parts: solid part and pore space. Mineral particles and organic matter make up the solid part of the soil, while air and water occupy the pore space. Soils vary in their proportions of these components, and the proportions affect the quality of the soil for agricultural use.

For ideal plant growth, an agricultural soil needs to provide:

- at least 15 cm of topsoil, composed of 45% mineral particles, 5% organic matter and 50% pore space
- a loamy texture and aggregated structure
- living microbes and invertebrates
- a balanced supply of nutrients, and
- correct acidity (pH).

In such a soil, with adequate rainfall and good management, crops should flourish.

Water and air are essential for plant growth and the activity of soil micro-organisms. The pore space allows for the exchange of gases between the soil and the atmosphere above the soil. The pore spaces also hold water under varying amounts of tension.

Mineral particles are grouped by size into three categories - sand, silt and clay. The proportion of these particles determines the soil texture. Texture has an important influence on many soil properties including size of pore space, water holding capacity, structure and tilth (the condition of soil as a result of cultivation), consistency (the feel of a soil at varying moisture contents) and bulk density (dry mass per unit volume of soil).

In this lesson, students will test soil samples with different textures in order to see how texture affects the properties mentioned above. One test will determine the mineral component of several soils; another will demonstrate the ability of different soils to absorb and hold moisture; and a third will demonstrate the ability of different soils to support plant growth.

> **NOTE**
> Test 1 has two parts which must be separated by a 30 minute settling time. Test 2 can be run and test 3 can be set up during this time. Test 3 must be monitored for one or two minutes a day for a week.

PROCEDURE

Part 1
Preparation

1. Gather a shovelful of soil from several different locations. If some of your students are from farms they may be able to bring samples. You can test any soil types that are available so long as you have several different ones. If forced by circumstances, you can make soils of different types by mixing potting soil, sand or perlite, and peat in different combinations. If possible, obtain samples that are definitely sandy, silty and clayey. Use these as a comparison or control.
2. Set up the testing apparatus for your students.

Part 2
Introduction

3. Explain that soils differ in their constituents and that these differences change a soil's value to plants.
4. Show your students the sample soils and divide them into as many groups as there are samples.
5. Give each group a soil sample and two 100 ml graduated cylinders.

Part 3
The Soil Test
Test 1, Part A

6. To determine the mineral composition of the soil, your students should:
   a) crush their soil and clear it of sticks, litter and large lumps.
   b) fill one cylinder to the 15 ml mark with loose soil.
   c) add enough water to fill the cylinder to the 45 ml mark.
   d) cover the cylinder opening with plastic wrap and shake it vigorously for at least three minutes. They must ensure that nothing spills and that large soil particles break up.
   e) set the cylinder down and let the contents settle for exactly 30 seconds.
   f) pour the water and suspended particles into the second cylinder to stand for 30 minutes, taking care not to pour out the settled layer.
   g) record the volume of settled solid in the first cylinder.
   h) take out the settled material.
   i) rub it between their fingers and record the consistency.

gritty	-	sand
slippery	-	silt
sticky	-	clay

Test 2

7. To test their sample for water holding capacity, your students should:
   a) saw the top and bottom off of a plastic bottle, keeping the cylindrical centre portion.
   b) fasten a filter cloth over one end with rubber bands.
   c) add 500 ml of their crushed and screened soil sample to the filter container.
   d) mount the container on a funnel above a graduated cylinder.
   e) quickly pour 200 ml of water into the top of the container, marking the start of the pour as time 0.
   f) record
      1. how long it takes for water to begin to drip through the filter.
      2. the total volume of water that drains out.

Test 3

8. To see how well the soil supports plant growth, each group should:
   a) fill a small plant pot with their soil.
   b) plant a few seeds in the pot, following package directions.

> **NOTE**
> All groups should use the same kinds of seed and grow them under the same conditions.

   c) put their test pot in a well lit place.
   d) add 25 ml of water daily.
   e) record the time until the seeds sprout, the daily increase in height for one week after sprouting and any other apparent changes in the plants as they grow.

Test 1, Part B

9. Once graduated cylinder 2 has settled for 30 minutes students should
   a) record the amount of settled material in the bottom of cylinder 2.
   b) pour off the water and suspended particles, without disturbing the settled layer.
   c) test the settled layer between their fingers and categorize it as previously done (step 3).

Part 4
Conclusion

10. Have the students compare results and ask them to briefly state how the mineral particle composition of soil affects its water holding capacity and its usefulness to plants.

DISCUSSION QUESTIONS

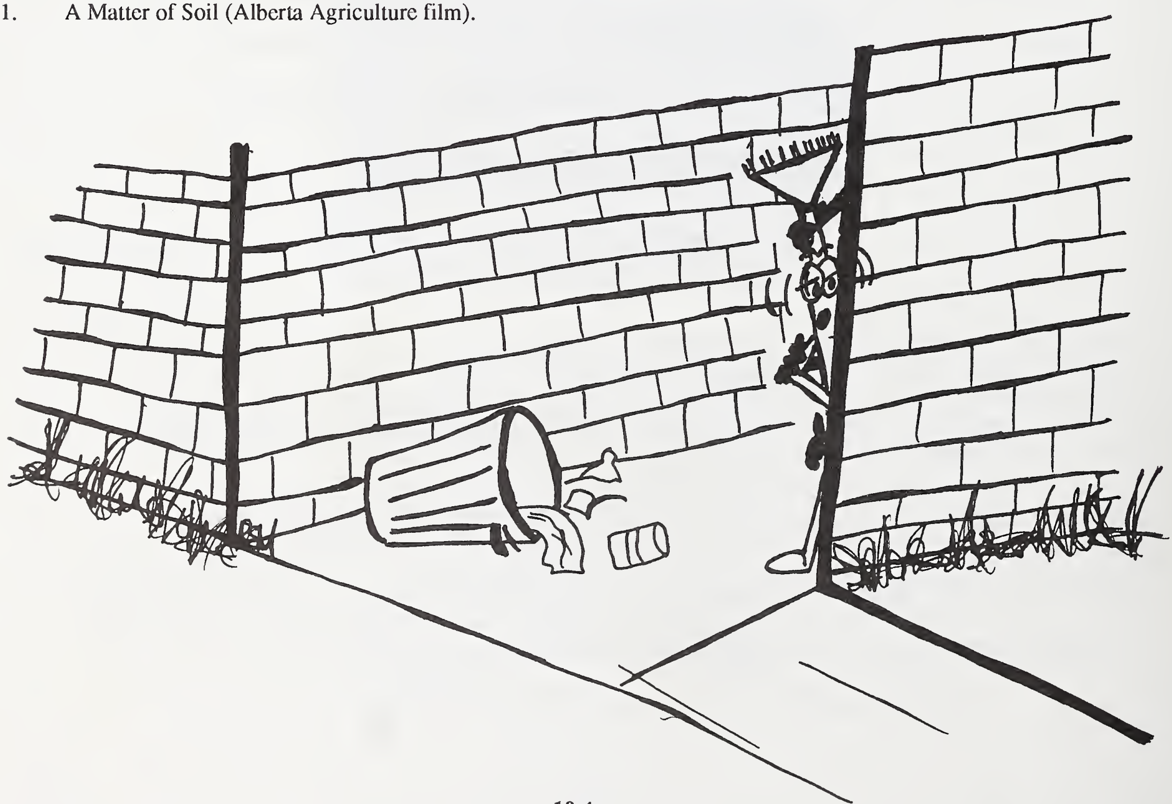
1. Why did the sand settle first?
2. Why do you not wait for the clay to settle?
3. The best soils, called loams, are even-textured. How does your soil compare?
4. Which soil type held water the best? Why?
5. What is the relationship between size/number of pores and adhesion/cohesion forces?
6. What is humus and what role does it play in plant growth?
7. Which soil type yielded the fastest sprouting seeds?
8. Which soil type yielded the fastest growing sprouts? Why?

RELATED ACTIVITIES

1. Take your students on a field trip to various locations comparing soil horizons (topsoil, subsoil, parent material) by obtaining soil profiles with a shovel. Observe the vegetation on topsoils of different thicknesses or in moist versus dry locations.

OUTSIDE RESOURCES

1. A Matter of Soil (Alberta Agriculture film).



Soil ready to do its work.

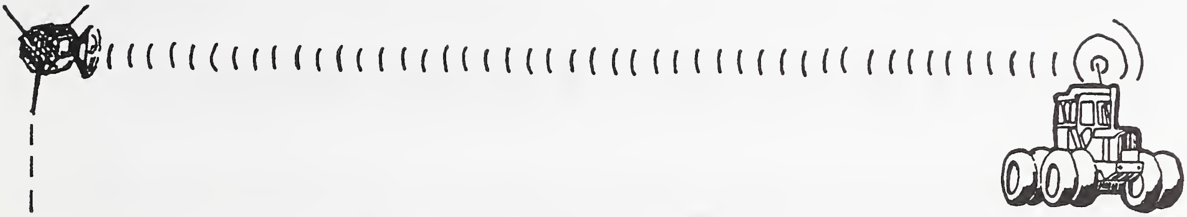
Preparing the soil for planting.

Above - Strip farming to conserve soil.

Left - A student project on soil conservation.

H.T. Coutts School
1987 Agricultural Fair.
Claresholm, Alberta.

Activity 11



THE INCREDIBLE NATION-WIDE BALANCING ACT

OBJECTIVE:

Through applying several classroom activities to agricultural case studies, students will be able to define optimum and maximum as these concepts apply in agriculture.

CURRICULUM FIT:

GRADE EIGHT - SCIENCE
- Topic 6: Interactions and Environments
- Awareness of the complex interrelationships among living things and their environments
- Awareness of the nature and extent of impacts on environments caused by human actions

AGRICULTURE CONCEPTS:

Economic importance

COGNITIVE LEVEL:

Comprehension, Application, Evaluation

MATERIALS REQUIRED:

- cups or glasses
- water
- 6 buckets
- measuring container
- mop and pail

TIME REQUIRED:

1 - 2 periods

BACKGROUND - For the Teacher

Producing as much of one commodity as possible is not necessarily the best strategy. Maximum output can lead to certain problems, such as the creation of excess water or the disruption of market prices by a glut output, whereby compromises are made between goals that are often conflicting.

For example, farms that are too small are not economically viable because they cannot produce enough to cover production and machinery costs and still leave the farmer with enough profits to live on. Such farms, if they do manage to continue in operation, are labour intensive since they cannot support much mechanization. On the other hand, farms which are too large cannot be operated efficiently enough to make the best use of land and human resources. The shortness of the growing season and difficulties in getting experienced farm labour often doom excessively large operations. The optimum scale then, lies between these two extremes where a farmer has enough land and livestock to support the use of large, efficient machinery, yet not so much as to require unavailable extra manpower to complete the work.

In this activity your students will learn that maximum production is not necessarily optimum production. Just as farmers must control their production to reach optimum levels, so students must control their production, in both the mock quiz and the bucket brigade race, to achieve optimum results.

Treat the mock quiz like any other quiz you give the students - they must take it seriously for the concept to work. In the bucket brigade race, you must act as a judge making sure all spilt cups are eliminated from the race.

PROCEDURE

Part 1
Preparation

1. Make copies of the Quick Quiz pages.
2. Arrange materials for the relay race demonstration.

Part 2
Introduction

3. Tell your students that you have a surprise quiz for them and that they have 1 minute to answer the questions.
4. After 1 minute, ask how many read the instructions. Then ask how many did not have time to answer the last question, which counted for 55% of the exam?
5. Ask your students what they hoped to accomplish in writing the quiz and how they went about the task.
6. Explain that many activities in life have multiple goals, some of which may conflict, and all of which must be considered in order to obtain optimum results.
7. Go over the quiz with your students just to emphasize the importance of the agricultural industry in Alberta.

Part 3
The Activity
Bucket Brigade Race (Part 1)

8. Divide students into 3 teams; team A fills their cups brimful; team B fills their cups to a level which ensures fast delivery with no spillage; team C fills their cups one quarter full.
9. The object of the game is to get the most water in a bucket in 3 minutes by relaying as many cups of water down a brigade as possible.
10. Spilled cups must be eliminated before reaching the bucket.
11. A team can start passing another cup as soon as they pour a cup into the bucket.
12. Compare water levels in the 3 buckets after 3 minutes are up.
13. Have each team clean-up their spilt water.

Bucket Brigade Race (Part 2)

14. Re-run the race as before. But this time, the teams must stop for 30 seconds after pouring 20 cups into the bucket.
15. Compare water levels in the 3 buckets after 3 minutes are up.
16. Use discussion questions after the game.
17. Again have each team clean-up their spilt water.

Part 4
Conclusion

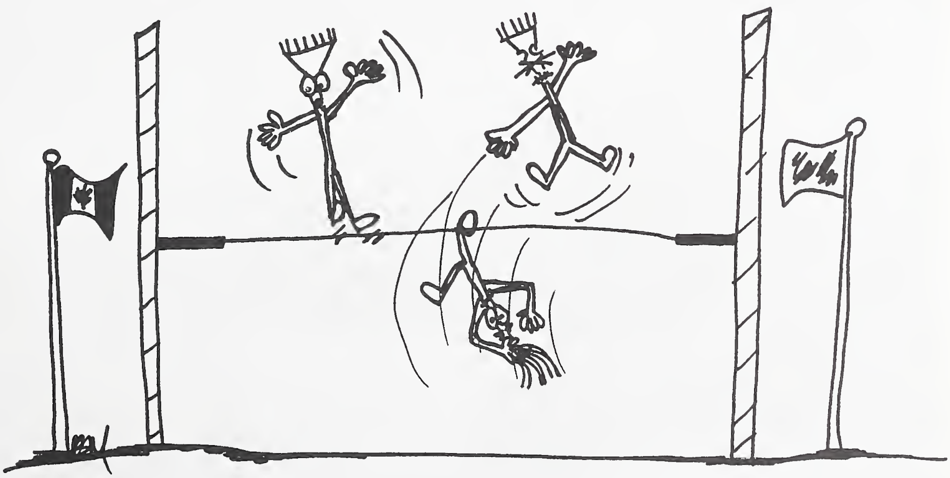
18. Explain that just as there were restrictions placed on the amount of water you could carry, farmers also have restrictions placed on the amount of crop and livestock they produce.
19. Hand out the case study to each student and then answer the questions.
20. Have students come up with a suitable definition for optimum and maximum from what they have learned in the lesson.

DISCUSSION QUESTIONS

1. How did you feel about the restriction in the Bucket Brigade Race?
2. What would happen if there were no restrictions?
   e.g. - no clean-up after the game
   - no penalty for water loss
   - no quota on amount of water that can be delivered
3. Is maximum always/ever optimum?

RELATED ACTIVITIES

1. Look for other case studies of optimization in farming:
   e.g. Fertilizer Use: Making sure added returns are greater than added costs.
   See Fertilizer Economics, Alberta Agriculture, July, 1985, Agdex 822-11.



Not too many, not too few. Produce just enough.

Case Study of Optimization in Farming

The Alberta Egg and Fowl Marketing Board, established in 1968, offered egg producers a supply management system. Prior to that time, the egg industry was very chaotic, with dramatic fluctuations in egg prices. If prices were favorable, farmers over-produced, which caused a drop in prices. Producers then cut back on their production, which led to shortages and high prices. Often there were a great many more eggs being produced than could be used. In establishing a marketing plan, producers accepted production limits in return for more stable incomes.

Now, the Board determines the number of eggs which consumers will need and sets production levels to meet that need. Each producer has a quota on how many eggs he may produce and market. He sells his eggs to a grading station, which sorts them according to size and grade. The eggs are then sold to retail stores, which sell them to you, the consumer. The price paid to producers for their eggs is determined using the "cost of production" formula which takes into account all the costs that go into producing eggs, including feed costs, the cost of laying hens, upkeep of buildings and equipment, labor, and a return on investment.

The figures that go into the pricing formula are based on the average costs of efficient producers as determined by the Board. This means that no farmer is guaranteed a good income; if a producer is inefficient, his income won't cover his expenditure. Pricing eggs in this way means there are no drastic price swings (as there were before stabilized pricing was introduced) and insures a steady supply of eggs to you, the consumer. Quotas were originally set up to be numbers of eggs, but it soon became evident that all eggs did not move off the farm to graders or processors. Since many producers grade their own eggs and sell them directly to the consumer, monitoring this kind of system proved impractical. As a result, quotas were converted to an equivalent number of hens permitted each producer. The quota then became all the eggs a producer could produce from a given number of hens. Under this system, the incentive to produce more eggs from the same number of hens is always present. Increased efficiency can result from better hens, management, equipment, feed formula or handling practices. As the laying rate improves, the production cost is reduced. This, in turn lowers the price of eggs to the consumer. Through this system the interests of consumers as well as producers are protected.

Questions for Analyzing the Case Study

1. What benefits result from a quota system?

   a) to the egg farmer?
   b) to you, the consumer?

2. How do you think the egg farmer would treat his chickens under this system?

3. If there are surplus eggs, why not just lower the price to get rid of them?

4. Do you consider this to be a fair system to all egg farmers; rich or poor?

5. How might you change this system?

The optimizing bird.

Quick Quiz

How much do you know about farming? Here's your chance to find out.

Circle what you think is the best answer for each question below. Don't be afraid to guess. Many adults don't know the answers to the questions.

Instructions:

You have 1 minute to complete this quiz. The first nine questions count one mark each. The last question counts eleven marks. The total marks possible is 20.

1. One Alberta farmer grows enough food and fiber each year to feed and clothe how many people?
- a) one
- b) 22
- c) 77
- d) 250

2. A large tractor used by an Alberta farmer may cost as much as how many new small cars?
- a) one
- b) two
- c) eight
- d) four cars and a dirt bike

3. One acre of land is about the same size as a:
- a) large swimming pool
- b) football field
- c) giant pizza
- d) tennis court

4. How long does it take a newborn calf to become full grown?
- a) 18 months
- b) 5 years
- c) 2 years
- d) 18 years

5. An average fully grown apple tree will produce apples for about how many pies every year?
- a) 25
- b) 2250
- c) 225
- d) I'm too busy eating pie to care

Quick Quiz (cont'd)

6. A single chicken lays how many eggs per year?
- a) 365½
- b) 100
- c) 420
- d) 240

7. Which crop in Alberta takes up more land than any other?
- a) wheat
- b) corn
- c) spaghetti
- d) cotton

8. One dairy cow produces how many glasses of milk daily?
- a) 150
- b) 1
- c) 72
- d) 12

9. To reach a market weight of 220 pounds, a pig must eat how many pounds of feed?
- a) 220
- b) 680
- c) 1000
- d) 100

10. How many carrots are there in the picture below?
- a) seven million
- b) one seventh
- c) none - those are watermelons
- d) seven

KEY

1.	c	6.	d
2.	c	7.	a
3.	b	8.	c
4.	a	9.	b
5.	c	10.	d

Activity 12

DON'T BUG ME

OBJECTIVE: Students will identify an insect, relate structure to function in terms of insect feeding habits, and propose efficient pest control methods.

CURRICULUM FIT:

GRADE EIGHT - SCIENCE
- Topic 6: Interactions and Environments

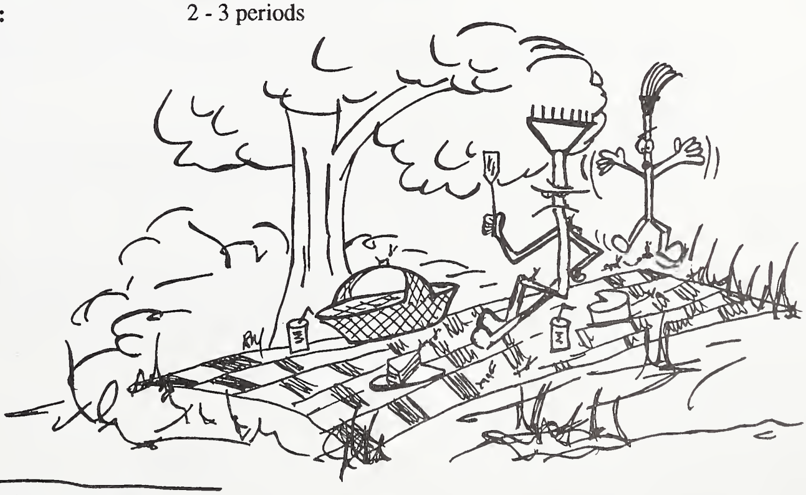
GRADE NINE - SCIENCE
- Topic 1: Diversity of Living Things
- Food chains and food webs
- Interdependencies of living things
- Adaptation in structure and behaviour
- Systems of classification - dichotomous grouping

AGRICULTURE CONCEPTS: Economic importance of agriculture
Production, processing and marketing systems

COGNITIVE LEVEL: Comprehension, Evaluation

MATERIALS REQUIRED: Real or illustrated insect specimens Box
Key of insect structure (attached)
Key to food sources (attached)
Farm layout (attached)
Insect information sheets (attached)

TIME REQUIRED: 2 - 3 periods



BACKGROUND - For the Teacher

Insects are probably the most successful of all animals. There are more than one million identified species distributed in virtually all freshwater and land regions of Earth. The small size of insects, their high reproductive rates and their ability to exploit suitable food supplies account for much of their success. Individual numbers are so large they defy comprehension. Insects appear in the fossil record from about 350 million years ago. Humans only arrived on the scene in the last several million years. Often, however, the coexistence between man and insect has not been harmonious. Insects play important roles in nature, from helping to decompose organic matter to pollinating plants to providing food for other animals. But some insect species also spread diseases or compete with humans for food.

In this lesson, students will identify 14 common agricultural insect pests of Alberta and their food source. By looking at the type of damage they do to agricultural products, students should infer a connection between structure and function. Students also consider pest control methods both economically and in terms of effectiveness.

Knowledge of insect life cycles and the relationship among pest, host plant and natural enemies help the pest manager to identify a suitable control method. Students will interpret given information about insect pests in order to come up with the best possible control method. An integrated system of pest management, one involving some or all of the proposed methods, is often best and students may discover this.

NOTE
The two identification keys will give your students experience in identifying unknown things by a process of dividing classes into progressively finer subclasses. This process is important in biology. However, in several instances, we have compromised the basic rule of taxonomy rule that you must always use permanent structural characteristics as the basis of identification. Most of these compromises occur in the key of food products and involve grouping by use rather than structure.

PROCEDURE

Part 1
Preparation

1. Photocopy the illustrated insect specimens (12-16-12-17), cut the cards apart and put them in a box.
2. Make one copy of each Insect Information Sheet (12-18-12-31) and one copy per group of the Insect Structure Key (12-10-12-11) and Food Source Key (12-12-12-13).
3. Make one large class copy of the Insect Structure Key and Food Source Key.

Part 2
Introduction

4. Show your students the box with the insect specimens inside it.
5. Tell them that you have some insect pests in the box and you are going to turn them loose on a farm. Ask students what is meant by "pest" and how an insect gets to be one.
6. Inform them that their job is to first identify the insect, then identify its food source and finally figure out a suitable control method for the pest.
7. Divide your class into groups of 2 or 3 and hand out copies of the Insect Structure Key and the Food Source Key to each group.

Part 3

Identifying Insects

8. Have each group of students:
   a) draw one insect out of the box;
   b) find the Insect Information Sheet for the insect;
   c) identify the insect by using the Insect Structure Key, the Food Source Key and the Insect Information Sheet;
   d) find the insect's food source (host) from the Insect Information Sheet;
   e) match the insect to its food source by drawing lines from the Insect Structure Key to the Food Source Key. Use the class copy for this. (There may be more than one line from each insect.)
   f) draw a small picture of the insect and place it on the class copy of the Insect Structure and Food Source Key.

Part 4

Choosing Pest Control Methods

9. Now divide your classroom into three sections - designate one section for the Cultural Control of Insects, one section for the Biological Control of Insects and one section to the Chemical Control of Insects. (See Data Sheet 2 for an explanation of these control methods.)
10. Have each group go to the section of the classroom that best represents the control method described on their Insect Information Sheet. Groups may discover that a combination of the three control methods is best.
11. Have the groups discuss ways of determining whether a pest control method is economically worthwhile and alternate control methods which might be possible.

FOR DISCUSSION

1. Do the mouth parts of mosquitoes and grasshoppers illustrate a connection between structure and function? Give examples.
2. How do farmers determine whether a pest control method is economically worthwhile?
3. To what degree is damaged food still suitable for human consumption?
4. What seems to be the best approach to pest control?
5. Does it help to know more about an insect pest when determining which control methods to use? Why?

RELATED ACTIVITIES

1. Investigate some of the more advanced and interesting pest control methods used on Alberta farms.
2. Find out the cost of various methods for controlling insects in dollars per acre.
3. Identify sources, ordering procedures, import restrictions and other information for biological control agents.
4. Develop a poster advocating one form of insect control.
5. Make a list of all of the pests the class can think of and ask each student to develop a dichotomous key that would allow an extra-terrestrial to separate them.
6. The two keys on Data Sheets 6 and 7 both break fundamental rules of key construction for life science. Find out what the rules are and evaluate these keys.
7. Have students establish a collection of insects that significantly affect agriculture.

Data Sheet One

What is a Pest?

A pest is any organism that adversely influences the welfare of humans by affecting their health, food or lodging. This can include anything from the tent caterpillar that consumes ornamental trees and strips the poplar of its leaves to the mosquito that carries equine encephalitis (sleeping sickness) to horses and humans, the warble fly grub that feeds off livestock, the bacterial ring rot that destroys potatoes in storage or the wild oat plant that reduces the yield of wheat.

Helpful Insects

Many insects are helpful to man, either directly or indirectly. Insects can be valuable for commercial reasons or for the important roles they play in maintaining the balance of nature. Assistance from beneficial insects could be essential to our survival.

At least fifty of our important food crops depend on pollinating insects, such as bees, for setting of fruit and resultant seed. Insect pests would ruin crops and vegetation but for predatory insects that capture and feed on them. Parasitic species also help to check insect pests. Scavenger insects aid in the decomposition of organic matter while some insects help to aerate, fertilize and condition the soil. There are insects that make shellac, dyes or pigments. The silkworm produces silk and bees make honey and beeswax. Insects also provide food for fish and animals, produce certain medicinal substances and aid in scientific research.

Knowing man's friends in the insect world can be important in controlling his enemies. Entomologists study the life cycles of the beneficial insects, learning how to use them to our fullest advantage.

Data Sheet Two

Insect Management Strategies

Certain weeds, insects and microorganisms exploit the agricultural environment, using a significant portion of our yearly harvest if they are not controlled. Farmers use many methods to control this.

Chemical Methods of Pest Control

Chemical methods mainly include the use of pesticides such as herbicides, insecticides and fungicides. Pesticide-resistant organisms and examples of harmful side effects from chemicals have made it necessary to use different methods of controlling pests. The alternatives include cultural and biological control and integrated pest management.

Cultural Methods of Pest Control

Cultural methods of pest control include using physical or mechanical means to prevent pests from getting established. Foremost among these are tillage, crop rotation, summerfallow and the use of weed-free seed.

Biological Control

Biological control of pests depends on the use of living organisms to keep pests from multiplying out of control. These control organisms may act on the pest through predation, parasitism or infection.

Integrated Pest Management

If all the available methods of controlling pests are used in combination, rather than individually, more effective pest control can be achieved. Cultural, biological and chemical methods can be integrated into a total package of pest control called integrated pest management. This strategy depends on a detailed knowledge of the life cycle and natural history of each pest species.

Data Sheet Three
Insect Life Cycles

Metamorphosis

Newly hatched insects often do not resemble the adult form. These immature insects must undergo changes in form. All young insects undergo metamorphosis whether this be simply increasing in size or acquiring new adult structure. The two common types of metamorphosis are incomplete (simple) and complete.

Incomplete (Simple) Metamorphosis

This form of metamorphosis includes three developmental stages: egg, nymph and adult. The nymph closely resembles the adult except in size, color, shape and/or presence of wings and sex organs. As the nymphs mature, they gradually become more similar to the adult. As the nymphs grow, they must undergo a series of molts at which time they shed their rigid exo-skeleton or "skin". With few exceptions, both adults and nymphs display similar habits, and live and feed on the same host. Some insects showing this life cycle are grasshoppers, aphids, thrips and lice.

Complete Metamorphosis

This life cycle includes a metamorphosis through four developmental stages: egg, larva, pupa, adult. In this type of development, the young or larvae (e.g. maggots, caterpillar, grubs) do not resemble the adults. Larvae, like nymphs, require periodic shedding of the "skin" in order to grow before transforming into inactive pupae. Pupae are usually covered by a cocoon or some other protective coating. During this stage of development, extensive tissue reorganization occurs in which adult structures replace larval structures. Insects with this life cycle pattern include flies, beetles, moths, and keds.

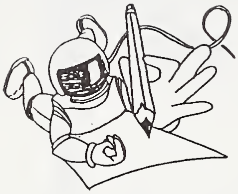
Data Sheet Four

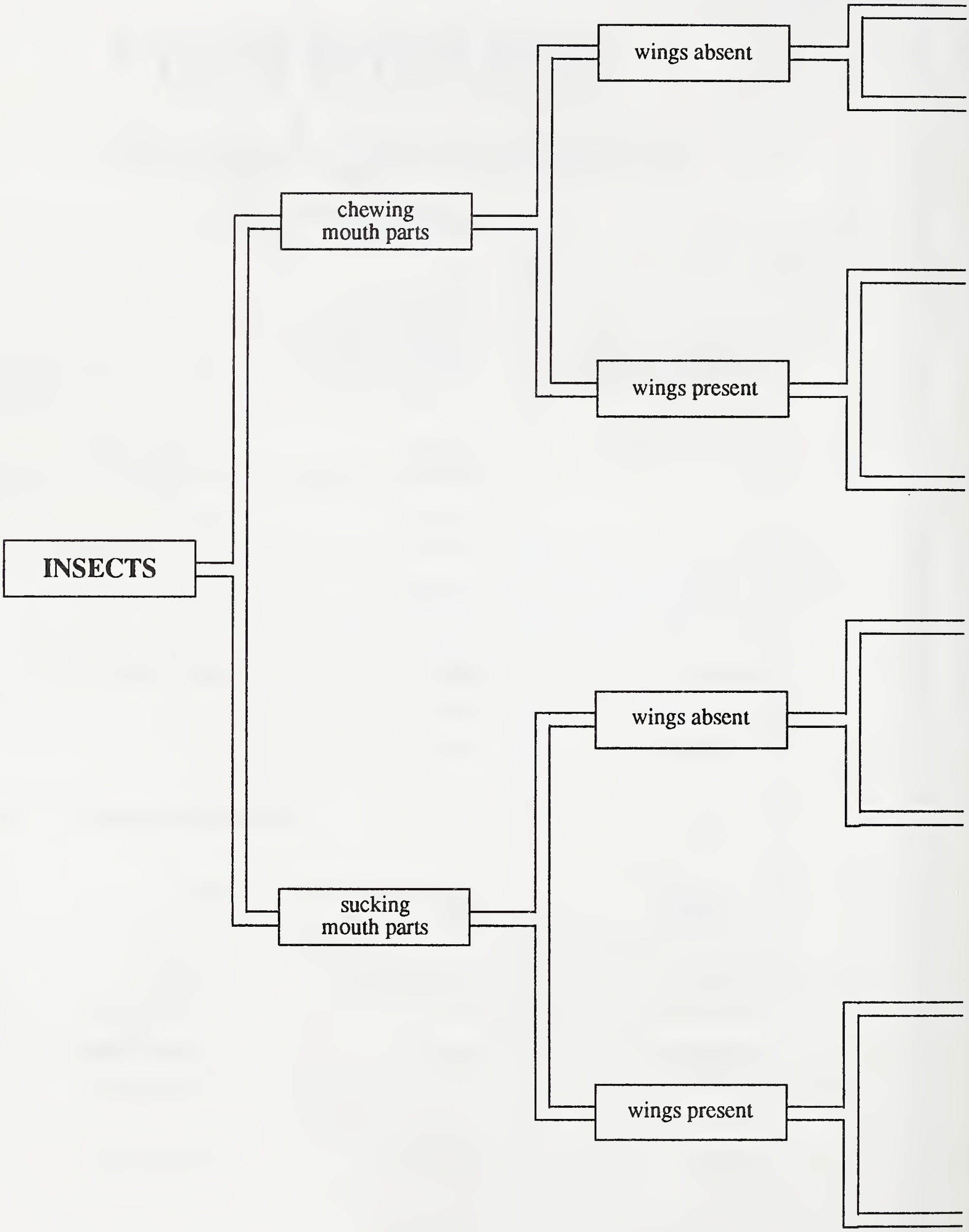
Developmental Stages When Insect is an Agricultural Pest

Insect in Key	Type of Metamorphosis	Pest Stage(s)
grasshopper	simple	nymph/adult
sawfly	complete	larva
wireworm	complete	larva
bug	simple	nymph/adult
looper	complete	larva
beetle	complete	larva/adult
weevil	complete	adult
thrips	intermediate	adult
aphid	simple	nymph/adult (female)
grub	complete	larva/adult
mosquito	complete	adult (female)
biting louse	simple	nymph/adult

thrips - 4 development stages (egg, larva, pupa, adult) but larva resemble adults except for smaller size, lack of wings and paler color.

KEY TO INSECT STRUCTURE, PART A
**(continues into PART B)

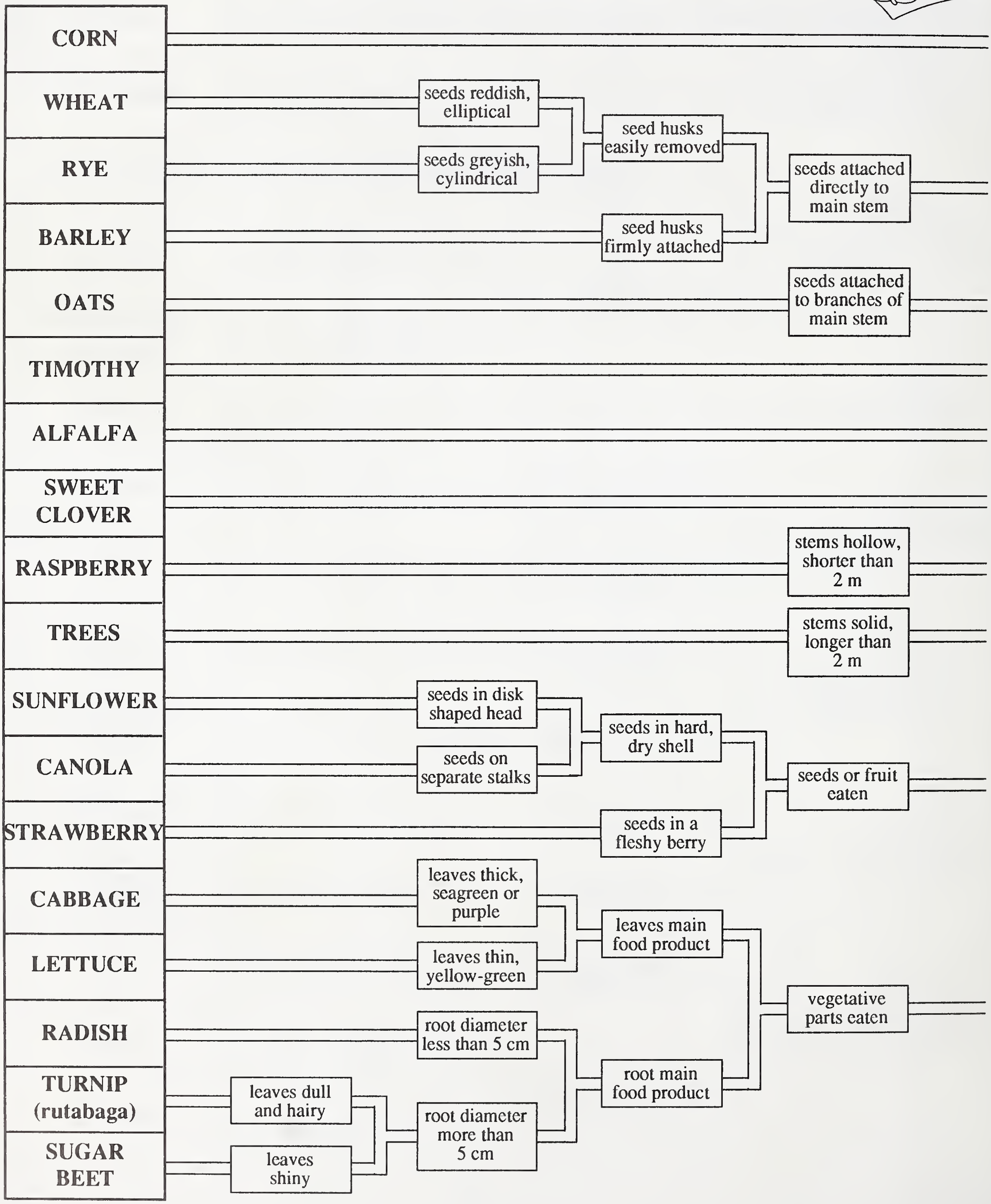




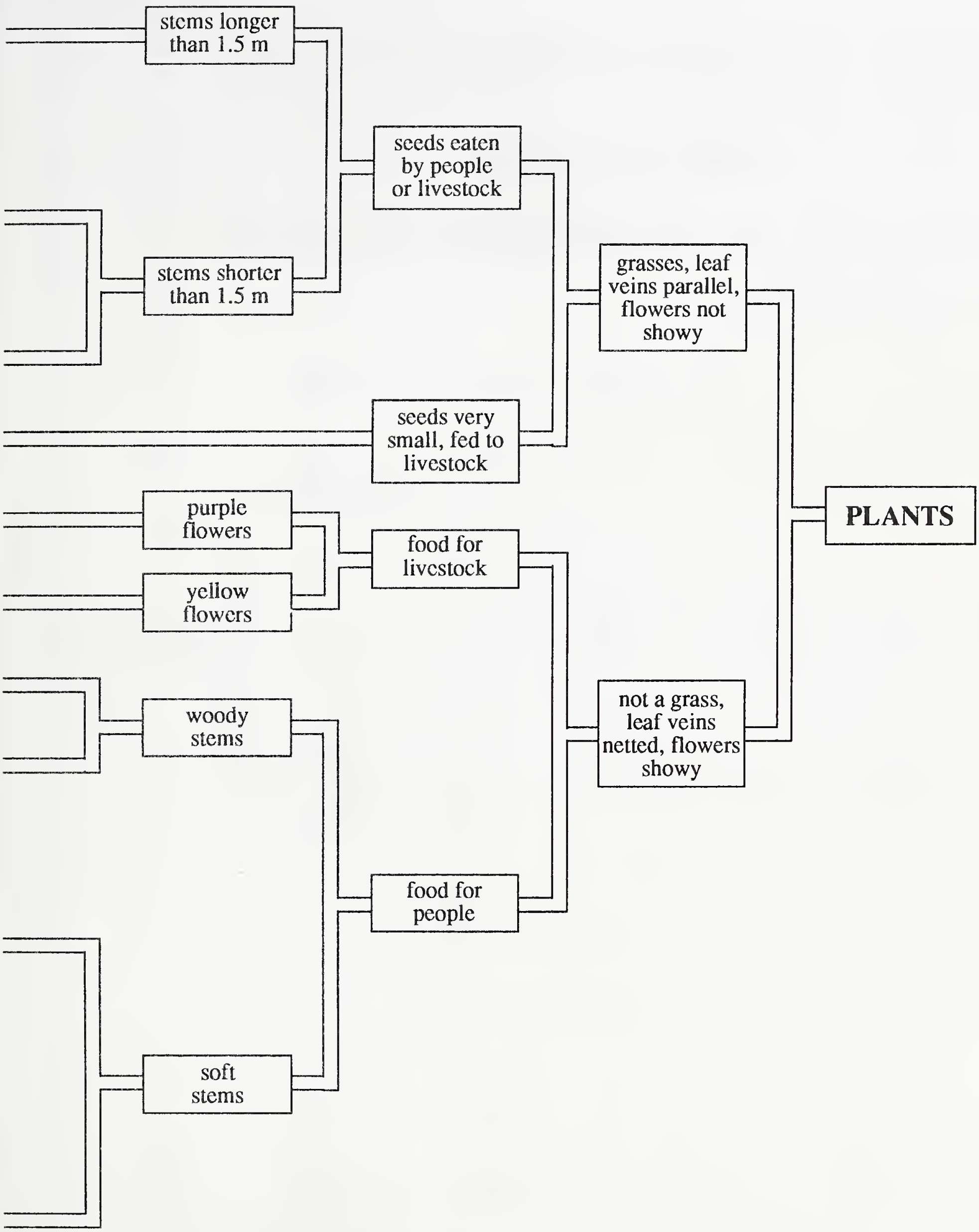
KEY TO INSECT STRUCTURE, PART B

- adult length less than 5 mm — **LOUSE**
- adult length more than 5 mm — **WIREWORM**
- front wings cover hind wings
  - front wings veined — **GRASSHOPPER**
  - front wings smooth
    - head with beak or snout — **WEEVIL**
    - head with no beak or snout — **RED TURNIP BEETLE**
- all wings obvious — **SAWFLY**
- adult length less than 5 mm
  - two cornicles* near tail end — **APHID**
  - cornicles absent — **KED**
- adult length more than 5 mm
  - body green with dark stripes — **ALFALFA LOOPER**
  - body dark grey — **WARBLE FLY GRUB**
- one pair of wings
  - antennae longer than head — **MOSQUITO**
  - antennae shorter than head — **HORSE BOT FLY**
- two pairs of wings
  - front wings cover hind wings — **BUG**
  - all wings obvious
    - two cornicles* near tail end — **APHID**
    - cornicles absent — **THRIPS**

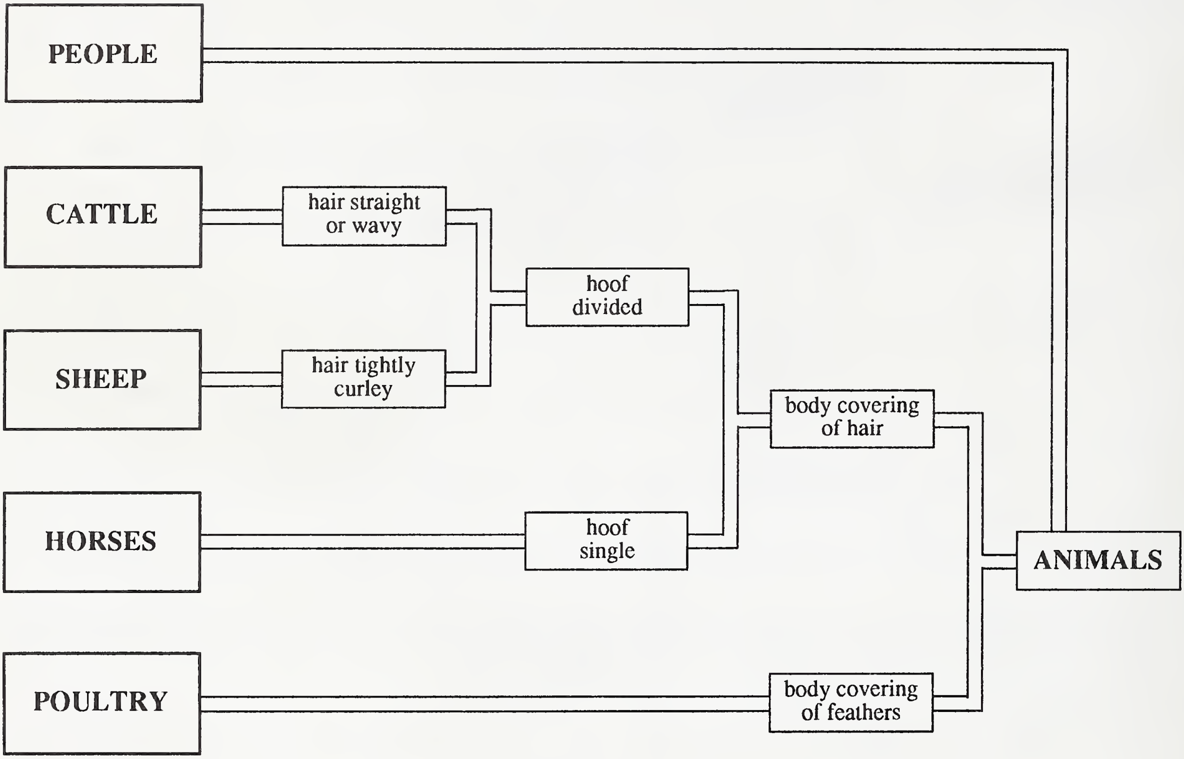
KEY TO FOOD SOURCES, PART A
**(continues into PART B)



KEY TO FOOD SOURCES, PART B



KEY TO ANIMAL HOSTS

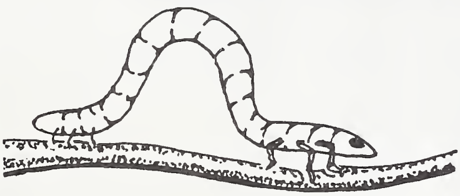


TEACHER'S SHEET ONE
Key to the
Insect Information Sheets

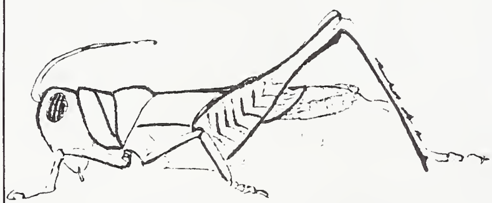
IIS 1 Alfalfa looper
IIS 2 Grasshopper
IIS 3 Plant bug
IIS 4 Mosquito
IIS 5 Ked
IIS 6 Warble fly grub
IIS 7 Horse Bot Fly
IIS 8 Thrips
IIS 9 Aphid
a) winged
b) wingless
IIS 10 Weevil
IIS 11 Sawfly
IIS 12 Louse
IIS 13 Red turnip beetle
IIS 14 Wireworms

TEACHER'S SHEET TWO
Unidentified Insects

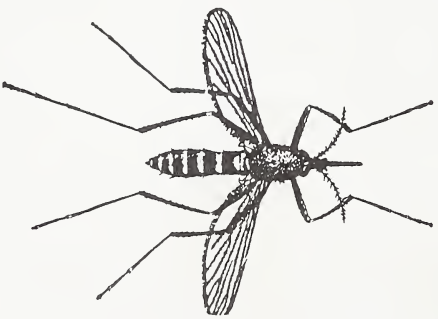
1.



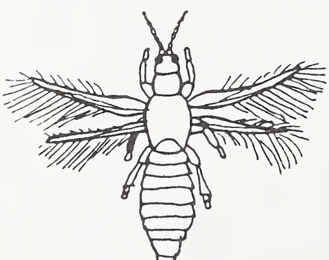
2.



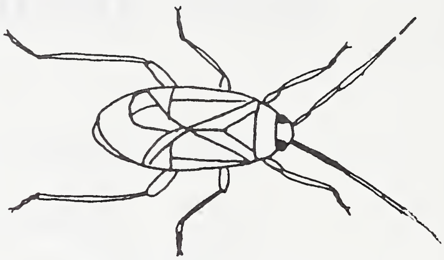
3.



4.

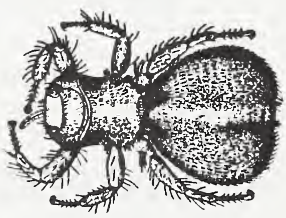


5.



6.

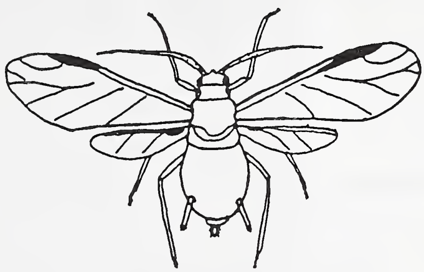
7.



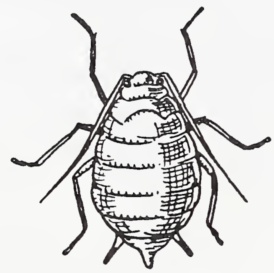
8.

TEACHER'S SHEET THREE
Unidentified Insects

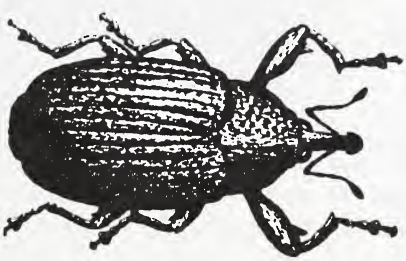
9. a



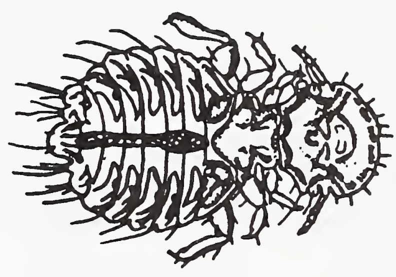
12.



9. b

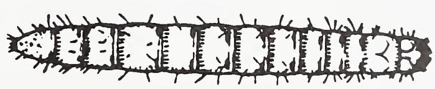


13.

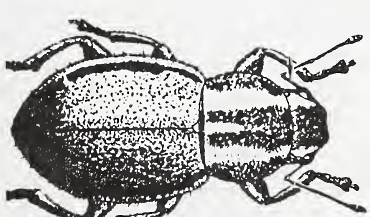


10.

14.



11.



Insect Information Sheet One

Characteristics

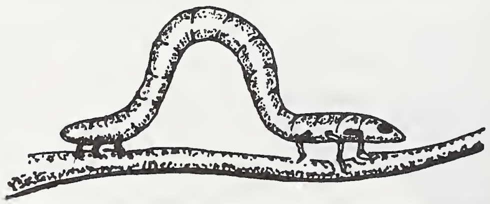
- ❐ This pest is the larva of a gray moth.
- ❐ It is olive green in color with a pale head and dark stripes down sides and back.
- ❐ Larvae feed for about 4 weeks before attaching themselves to a plant and spinning a woolly cocoon in which to pupate.
- ❐ Moves by bringing its hind legs forward, then releasing its front legs and extending its body forward.
- ❐ Mature larvae are about 25 mm long.
- ❐ Commonly 3 broods a year.
- ❐ Over winters as pupa.

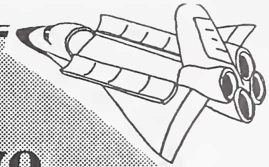
Hosts

- ❐ They suck the sap from alfalfa and canola.
- ❐ The plants can normally recover unless severe damage occurs due to a large population.

Control

- ❐ Normally numbers are limited by natural parasites and predators.
- ❐ At least one virus species is known to be pathogenic.
- ❐ Insecticides include chlorpyrifos and methomyl. However, these must be applied at least 21 days before harvest.





Insect Information Sheet Two

Characteristics

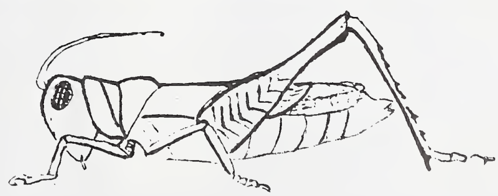
- ❐ Over winter as egg, hatch as a nymph, less than 6 mm long.
- ❐ Adults and nymphs feed on vegetation.
- ❐ Adults 21 - 40 mm long.
- ❐ Two pairs of wings: forewings are veined and cover hindwings; hindwings are transparent.

Hosts

- ❐ This pest feeds primarily on native grasses and seeds.
- ❐ Causes damage to cereal crops at the edges of fields (damage to grasslands is more evenly distributed).
- ❐ Damage to cereals include leaf stripping and clipping of heads.
- ❐ Will chew any plant or plant product.

Control

- ❐ Control by cultivating stubble immediately after harvest to destroy eggs.
- ❐ Weed control is important to discourage egg laying.
- ❐ Seed early.
- ❐ Summerfallow in heavily infested areas.
- ❐ Use "trap strips" (rows of cultivated and uncultivated field) in order to concentrate the pest in smaller areas then use insecticide on those areas.
- ❐ Predators include the blister beetle (feeds on eggs).
- ❐ Pathogens include a fungus disease which leaves corpses clinging to stems.
- ❐ Parasites include wasps.
- ❐ Insecticides include carbaryl and methamidophos (do not apply within 10 days of harvest).



Insect Information Sheet Three

Characteristics

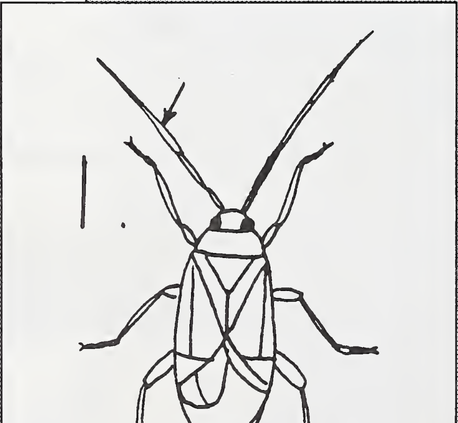
- ❒ This family of pests feeds on blossoms in bud stage, on flowers and on young seedlings by sucking up plant juices with needle like mouthpart.
- ❒ Two pairs of wings, forewings cover hindwings.

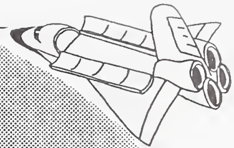
Hosts

- ❒ Alfalfa
- ❒ Do not affect feed quality, but, reduce or prevent seed development.

Control

- ❒ Removal of weeds reduces hiding places.
- ❒ Predators include the ladybird beetle.
- ❒ Spring burning of stubble destroys eggs of many species.
- ❒ Chemical control with dimethoate 4E or others.





Insect Information Sheet Four

Characteristics

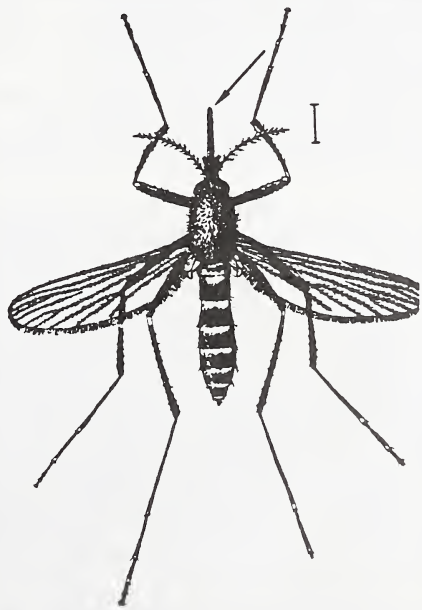
- ❐ This pest lays its eggs around water and eggs are hatched underwater.
- ❐ One pair of wings.
- ❐ Antennae longer than head.

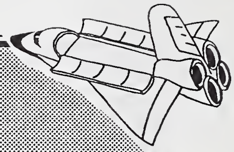
Hosts

- ❐ Larvae feed on organic matter in water.
- ❐ Female adults search for a blood meal after mating in order for egg to develop - sucks blood from all mammals, including humans.
- ❐ Can carry sleeping sickness.

Control

- ❐ Control pest through source reduction - drain stagnant waters around home.
- ❐ Electrocute using heat source and light.
- ❐ Hand killing is also possible, but slow.
- ❐ Chemical control at the larval stage only, by spraying stagnant waters.





Insect Information Sheet Five

Characteristics

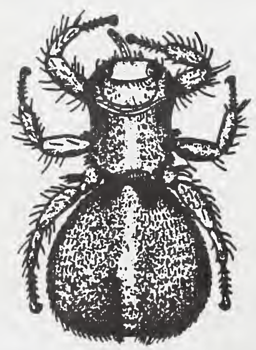
- ❒ This pest is a wingless fly which has become adapted to a tick-like existence.
- ❒ Adult feeds by piercing skin of the host and sucking its blood.
- ❒ Unique in that eggs hatch within uterus of female and the young larvae develop to maturity on food secreted by the nutritive glands of the mother.
- ❒ Mature larvae born after eight days of feeding and growing in the uterus.
- ❒ Pupae become cemented to the sheep's wool for 22 days then adults emerge.
- ❒ Entire life of adult is spent in the fleece of host.

Hosts

- ❒ Goats, sheep, especially the young.
- ❒ Insect bites result in a defect in sheepskins known as cockle. Quick recovery occurs if parasite is removed.

Control

- ❒ Farmer should feed sheep well, as well-fed lambs usually do not support as many pests as underfed lambs.
- ❒ Insecticides include diazinon which should be applied in spring after shearing when temperatures are at least 10°C.



Insect Information Sheet Six

Characteristics

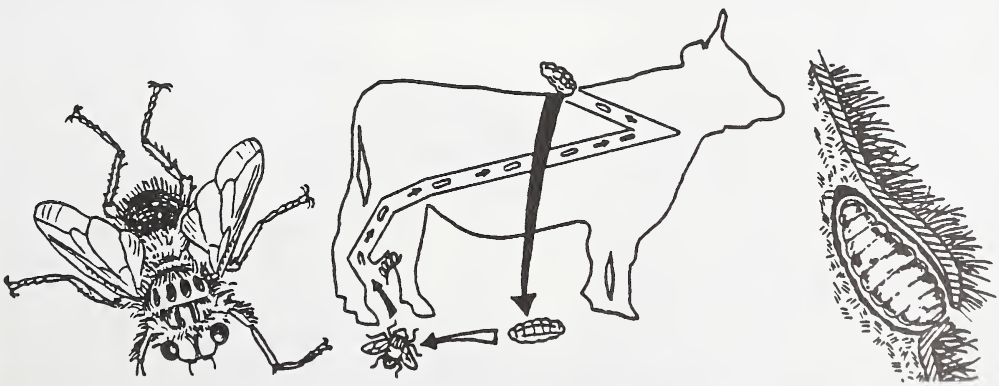
- ❐ This pest is the larva of a warble fly.
- ❐ It is dark grey in color with sucking mouth parts.

Hosts

- ❐ The adults lays eggs on cattle hairs.
- ❐ The larva hatches and burrow through the skin, wandering through the body until it reaches the back where it cuts a breathing hole.
- ❐ Remains in cow's body 7 - 9 months.
- ❐ Larva is dark gray, longer than 5 mm.
- ❐ When mature, it squeezes through the hole, falling to the soil where it pupates to eventually become the adult fly.

Control

- ❐ The insecticide rotenone can be rubbed onto warble openings in hide during the spring.
- ❐ Systemic insecticides can be applied to calves and adults in the autumn. Cannot treat calves smaller than 62 kg or milking cows or cattle to be slaughtered within 28 days.



Insect Information Sheet Seven

Characteristics

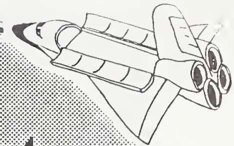
- ❒ Can be a serious pest where excess waste materials build up.
- ❒ Reproduce in manure and are capable of transmitting the stomach worm.
- ❒ Feed by sucking blood, especially during summer months.
- ❒ Antennae shorter than head.
- ❒ One pair of wings.
- ❒ External parasite

Hosts

- ❒ Horses, cattle, sheep

Control

- ❒ Keep stalls clean and freshly bedded.
- ❒ Good drainage from corrals.
- ❒ Remove dead animals to burying ground.
- ❒ Treat horse wounds.
- ❒ Prevent weed overgrowth to avoid hiding places.



Insect Information Sheet Eight

Characteristics

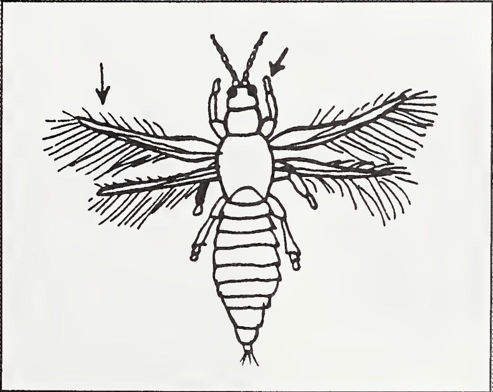
- ❒ This pest is small and slender.
- ❒ It feeds by rasping or piercing outer plant tissue, and sucking up the juices which escape.
- ❒ Damage appears as whitish blotches or streaks on leaves, flower buds and petals.
- ❒ Larva resemble adult even though it undergoes four developmental stages including pupal stage.

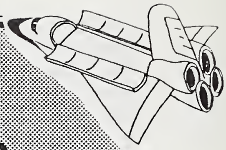
Hosts

- ❒ All plants, especially alfalfa and barley.

Control

- ❒ Under investigation
- ❒ Insecticides should not be used when clover crop is in bloom.
- ❒ Predators include the flower bug.





Insect Information Sheet Nine

Characteristics

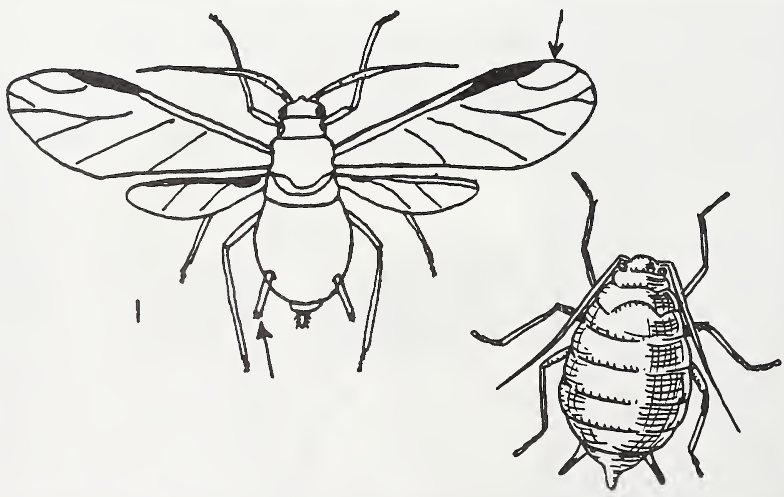
- ❒ This pest is small, oval and fragile.
- ❒ Adults may be either winged or wingless.
- ❒ It has piercing and sucking mouthparts.
- ❒ It reproduces both sexually (mating required) or partheno-genetically (mating not required).
- ❒ Males are not produced until early fall.

Hosts

- ❒ Injurious to all forms of plant life and may be found on tree bark, stems, leaves, blossoms, fruit and roots.

Control

- ❒ Predators include the lacewing.
- ❒ Parasites include the braconid wasp.
- ❒ The insecticide diazinon can be used on crops and trichlorfon on trees.
- ❒ Do not apply diazinon just before harvest.



Insect Information Sheet Ten

Characteristics

- ❐ 4 mm long.
- ❐ Dark grey in color.
- ❐ Prominent beak.
- ❐ 2 pairs of wings; forewings cover hindwings when at rest.

Hosts

- ❐ This pest causes defoliation of plants, especially legumes and fruit.
- ❐ Chews on alfalfa if no sweet clover is present.

Control

- ❐ Control by arranging crop rotations so that new clover fields are as far as possible from old ones.
- ❐ Sow clover early (before grain crops) and at proper depth to promote hardy vigorous seedlings.
- ❐ Cultivate clover silage and hay fields as soon as crop is removed in order to kill larvae.
- ❐ Predators include toads and grubs.
- ❐ Pathogens include a fungus disease.
- ❐ Insecticides include malathion, diazinon, methoxychlor. Do not use in houses - rather keep doors and windows closed, seal all cracks, and use broom or vacuum cleaner if pest is found in house.
- ❐ Insecticides not recommended for tree-infestations.

Insect Information Sheet Eleven

Characteristics

- ❐ This pest is wasp-like in appearance.
- ❐ Adults do not feed.
- ❐ Females lay eggs using saw-like ovipositor.
- ❐ Cannibalism occurs among newly hatched larvae.

Hosts

- ❐ Larvae chew on inside of wheat and rye stems - stem is weakened at a point just above ground level resulting in breakage by wind or rain.
- ❐ Fallen stems are difficult to harvest.

Control

- ❐ Control by swathing infested wheat after kernel moisture drops.
- ❐ Rotate crops to barley, oats, alfalfa, etc.
- ❐ Delay seeding in spring.
- ❐ Summerfallow infested stubble (burning also reduces numbers, but it reduces parasite numbers as well).
- ❐ Solid-stemmed resistant varieties of wheat can be tried.
- ❐ No insecticides are recommended.
- ❐ For infested trees, either hand pick the larvae or use acephate.

Insect Information Sheet Twelve

Characteristics

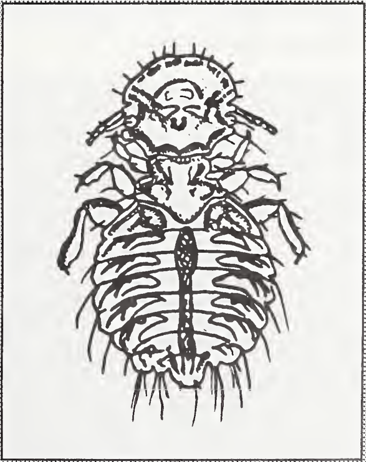
- ❐ This pest is small, wingless and flattened.
- ❐ It spends its entire life and development on host.

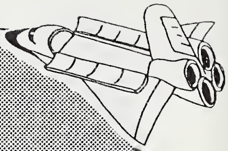
Hosts

- ❐ Major pest of poultry - chews primarily on bits of hair, feather, flakes of skin and other debris on hosts.
- ❐ Heavily infested hens appear dopey and listless; egg production decreases significantly.

Control

- ❐ Insecticides include malathion dust applied directly on birds, nicotine sulphate paint on roosts and lindane spray on litter. Do not apply within 7 days of slaughter.





Insect Information Sheet Thirteen

Characteristics

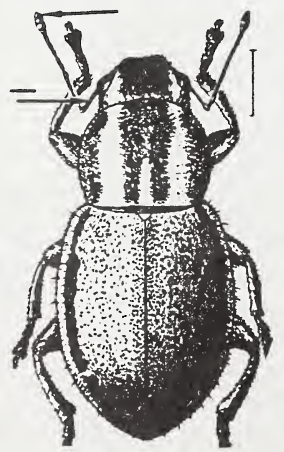
- ❒ 7 mm long.
- ❒ Adults bright red with black patches on head and 3 distinct black lines on the back.
- ❒ Over winter as eggs.
- ❒ Larvae black, slow moving, feed at night.
- ❒ Pupae bright orange.
- ❒ One generation per year.
- ❒ Two pairs of wings; forewings are smooth and act as covers for the hindwings when the insect is at rest.

Hosts

- ❒ This pest feeds on potato, cabbage, radish, turnip, rape, and other cruciferous plants.
- ❒ The larvae and adults chew on the flowers, seed pods and foliage.
- ❒ Adults are responsible for the greatest damage, especially in seedling canola.

Control

- ❒ Cultivate fields after harvest.
- ❒ Rotate crops.
- ❒ Predators include the fiery hunter.
- ❒ Pathogens include microsporidians.
- ❒ Insecticides include oziniphos-methyl, carbonfuranete (do not apply within 30 days of harvest).



Insect Information Sheet Fourteen

Characteristics

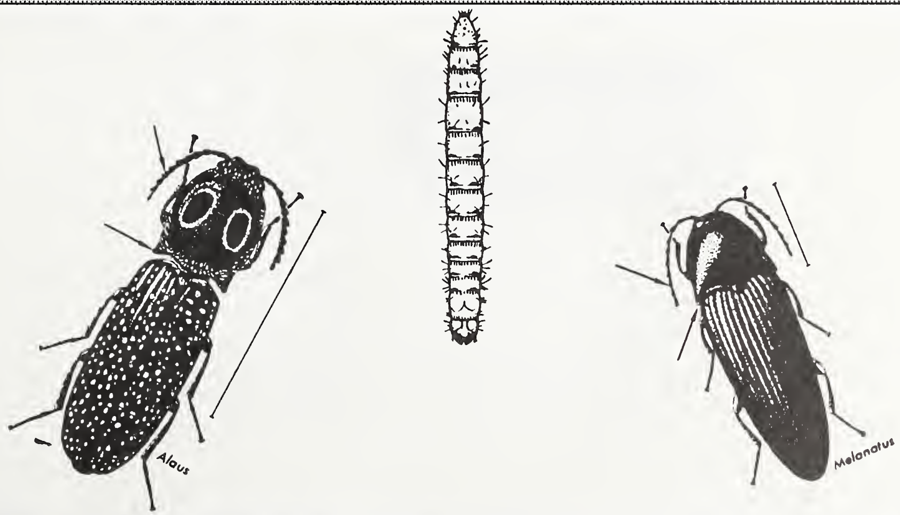
- ❒ Slender, hard bodies, usually yellow, up to 25 mm long.
- ❒ May live 5 - 10 years before pupating.
- ❒ Always found in soil.
- ❒ Chewing mouth parts.

Host

- ❒ Roots or germinating seeds of cereal crops and roots of potatoes, sugar beets, corn, lettuce and sunflower seeds.
- ❒ Can go for 2 years without food if they survive first winter.

Control

- ❒ Control by rotating grass with cereal crop.
- ❒ Insecticide called lindane can be used as a seed dressing.



Activity 13

WORM RANCH I

OBJECTIVE: Students establish, observe and interpret an earthworm colony in stratified soil.

CURRICULUM FIT: **GRADE EIGHT - SCIENCE**

- Topic 6: Interactions and Environments
- Interaction of living things and environments
- Light, soil and temperature needs
- Food chains and food webs

AGRICULTURE CONCEPTS: Importance of soil and water

COGNITIVE LEVEL: Knowledge, Comprehension, Application

MATERIALS REQUIRED: Two worm ranch vivariums.
Topsoil mix, clay soil, sand, fine grave.
Wilted grass clippings.
20 - 40 live earthworms.

TIME REQUIRED: One class to set up.
2 to 5 minutes per day for observation over 5 days.
20 minutes for conclusions.

> **NOTE**
> This is an especially good idea for a science fair project.

BACKGROUND - For the Teacher

Historically, production agriculture has consisted of developing localized environments where conditions for raising food, plants and animals could be established and maintained. In this way, farming has come to be one of the land uses by which people exercise their widest effects on the environment.

At the same time as it affects the environment, production agriculture also depends on the environment. Soil, light and water requirements are important and well known crop-limiting variables. However, farming also depends on organisms that affect these well known conditions in the environment without being directly cultivated.

In this activity your students are to observe the activities of a population of earthworms and draw conclusions about their effects on the soil and therefore on plant growth. As a result, they will gain an understanding of some interactions between one organism and its environment. At the same time they will see how farming, and therefore their food, depends on the activity of soil animals that are rarely given any conscious attention by farmers or food consumers.

On Task Sheet One, students record information about soil drainage of water. This information not only provides a comparison between the two sub-soils, but is also important for before and after comparisons that will be made in the activity Worm Ranch II.

PROCEDURE

Part 1
Preparation

1. Obtain or build two of the soil vivariums described in Teacher Resource Sheet One.
2. Gather the other materials listed or assign their gathering to students.

Part 2
Introduction

3. Review students' existing knowledge of earthworms and their effect on soil.
4. Explain that students will now be looking at earthworms from two points of view:
   a) What do earthworms need for their surroundings?
   b) How do earthworms affect the soil?
5. Divide the class in two equal groups, and give each group a copy of Data Sheet One.
6. Explain that each group will supervise one worm ranch project.

Part 3
Activity

7. Have each group fill their worm ranch in the pattern shown on Data Sheet One.
   a) Students should record the amounts of each material used on Task Sheet One.
   b) Students should level each layer before adding the next.
   c) When all layers are in place, students should gently add water from the top until it begins to drain from the bottom of the frame.
8. As soon as the apparatus stops draining, students place up to 20 earthworms on the surface and observe their activity over the next five minutes. They can record their observations on Task Sheet Two.
9. For the next five classes students should observe the worm ranch each day and record their observations on Tasks Sheets Three and Four.

Part 4
Conclusion

10. Have each working group present their results from the week.
11. Lead the class in a discussion on the questions on the following page.

DISCUSSION QUESTIONS

1. Did the worms in the two ranches show different burrowing patterns?
2. If there were differences, what might have caused them?
3. Was there evidence of mixing between layers of soil?
4. Was there evidence of what the worms were eating?
5. If earthworms eat surface organic matter and excrete fine, mineral rich soil, what role are they playing in the food chain?
6. How does the earthworm's niche help farmers and gardeners?
7. Which type of subsoil would be better for gardening and farming? What other factors determine the answer to this question?
8. What do farmers and gardeners do that loosens and mixes the soil like earthworms?

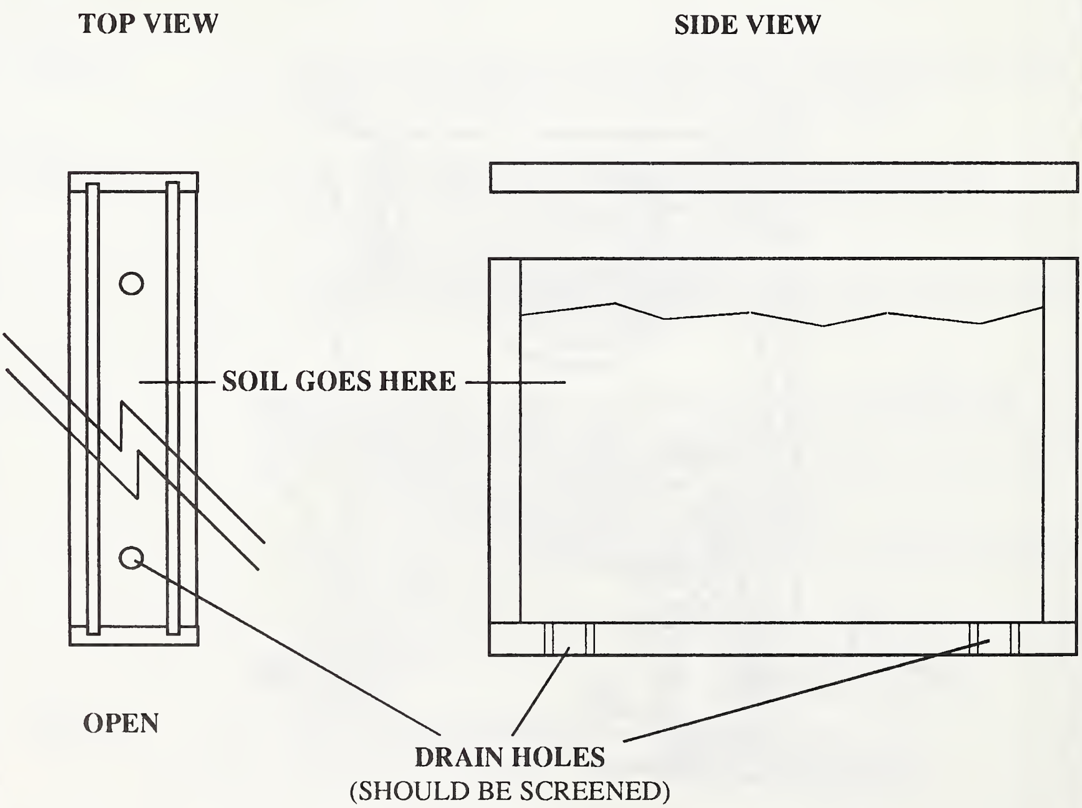
RELATED ACTIVITIES

1. Hold a debate on the resolution "Earthworms are the sign of a healthy soil, not the cause of a healthy soil".
2. If you use the Science Plus series as a text, you will find some simple anatomical and behavioral experiments in Chapter One of Science Plus 1.
3. To see how earthworms react to flooding in their environment, students should do the activity Worm Ranch II.

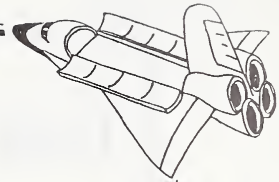
Teacher Resource Sheet One
Building A Worm Ranch

Your worm ranch is a narrow, glass-sided vivarium, commonly known as an ant farm.

It consists of glass held 3-4 cm apart by a frame, with the space between filled with soil.

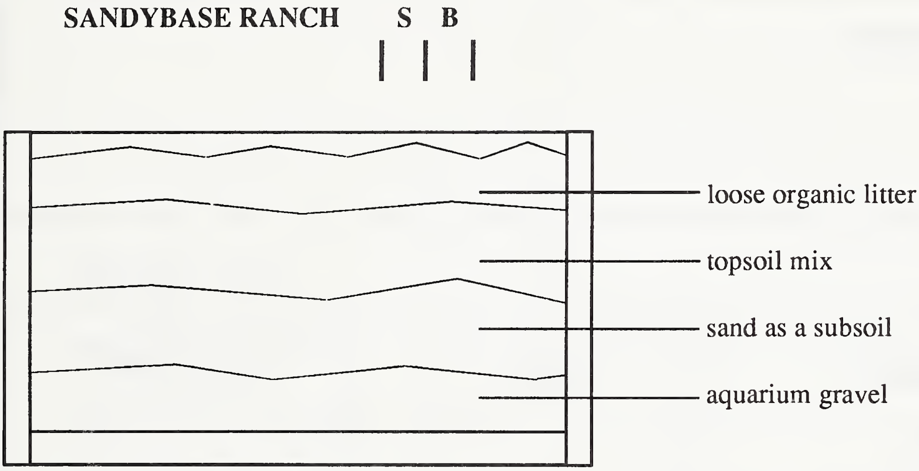


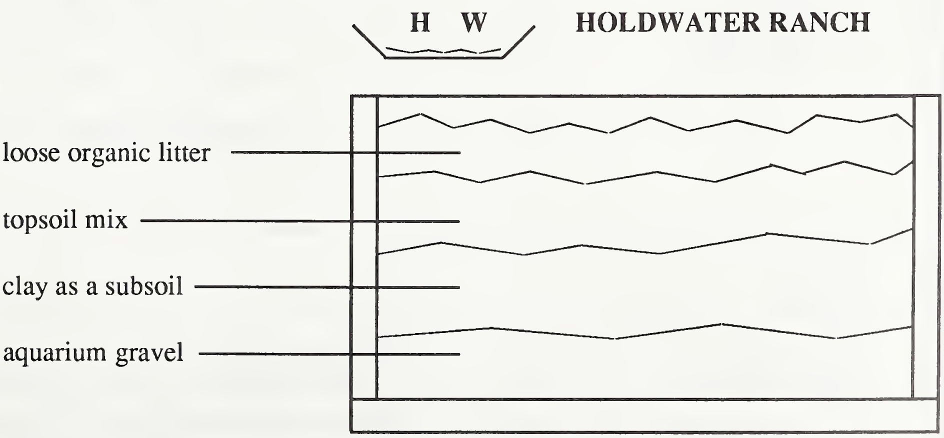
It is important to have opaque covers for each side of the worm ranch. Soil organisms are all highly light sensitive and will only tunnel near the glass if it is covered between observations.



Data Sheet One — Preparing and Stocking the Worm Ranch

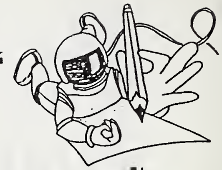
For this activity and Worm Ranch II you need to fill two soil vivariums with layers of soil as illustrated.





The exact depths of each layer is not critical. All layers but the sub-soil should be the same.

Each ranch can be stocked with up to 20 earthworms.



Task Sheet One — Ready the Ranch

RANCH NAME: ____________________

Team Members:

Material	Volume	Mass in Grams
gravel		
sub-soil		
topsoil mix		
surface litter		

WATER	
Volume added ________	Time elapsed before draining begins ________
Volume draining ________	Time elapsed when draining is complete ________
Volume held in soil ________	

Task Sheet Two — Stocking the Ranch

RANCH NAME: ______________________________

Team Members:

OBSERVATIONS

Number of worms added: ______________________

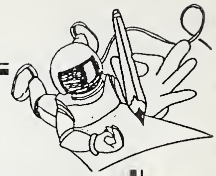
Time until first movements: ______________________

Time until digging begins: ______________________

Time until worms all underground: ______________________

GENERAL OBSERVATIONS

Possible explanations of observed behaviours.



Task Sheet Three — Riding the Range

Ranch Name

____

Viewing Day

____

Team Members

OBSERVATIONS

Is litter changing or disappearing?

Are there castings on the soil surface?

If so, how do they differ from soil and litter?

Are tunnel openings visible at the surface?

Is there any visible mixing of soil layers?

What layers are tunnels visible in?

GENERAL COMMENTS

Task Sheet Four — Mapping the Range

1. Use the grid to make a scale diagram of the side of the worm ranch.

2. Each day mark the locations of visible tunnel sections and earthworms.

Activity 14

WORM RANCH II

OBJECTIVE: Students drench vivariums with water, observing and recording the patterns water follows through the soil.

CURRICULUM FIT: **GRADE EIGHT - SCIENCE**

- Topic 6: Interactions and Environments
- Interaction of living things and environments
- Light, soil and temperature needs

AGRICULTURE CONCEPTS: Importance of soil and water

COGNITIVE LEVEL: Comprehension, Application, Analysis

MATERIALS REQUIRED: Worm ranches established in the preceding lesson.
Water.
Two water bottles with sprinkler attachments.

TIME REQUIRED: One class period.

NOTE
This is an especially good idea for a science fair project.

BACKGROUND - For the Teacher

From their work in Worm Ranch I your students have observed some of the behaviour of earthworms and how this behaviour affects soil. In this activity students are to conduct an experiment that will give them information in two areas:

i) Has the presence of earthworms affected the way water percolates through the soil?
ii) How do earthworms respond to a drenching of the soil?

Your students will need information they recorded on Task Sheet One of the activity called Worm Ranch I.

PROCEDURE

Part 1
Preparation

1. If your students have done the activity Worm Ranch I, then you need only ensure that sprinkler equipment is available.
2. If your students have not done Worm Ranch I, then you need to establish and stock a soil vivarium using the guidelines in Data Sheet One and Teacher Resource Sheet One (from Worm Ranch I). The earthworms will need about a week to establish tunnels before you do this activity.

Part 2
Introduction

3. Briefly review existing knowledge about earthworms.
4. Ask the students:
   a) What do earthworms do when it rains heavily for a long time?
   b) Why do you suppose they do that?
5. Explain that students are to conduct an experiment that will consider two questions:
   a) Does the presence of earthworms affect the way water runs through soil?
   b) How do earthworms respond to drenching of the soil?

Part 3
Activity

6. Distribute Task Sheet One and ensure each team knows what information they are to gather.

> **NOTE**
> Teams will get the best observations if they divide up tasks so that some pour water, some observe water flow, some observe earthworms and some capture draining water, and some keep time.

7. Have students begin top watering of the vivarium. Students are to record data as changes occur; their notes should include the time elapsed when each event occurs. The start of watering should be time 0:00.

Part 4
Conclusion

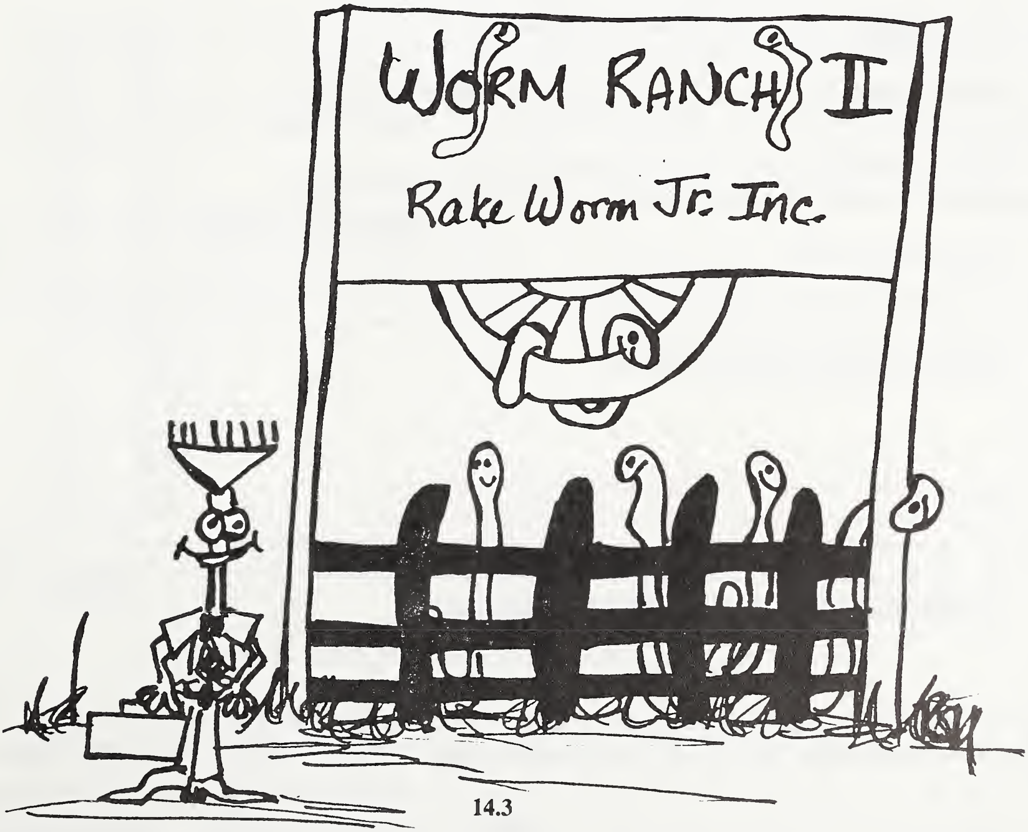
8. Have each team tell its results, including a comparison with the initial drainage times and amounts.
9. As a class consider the questions:
   a) Do earthworms affect soil drainage and water holding capacity?
   b) Do earthworms affect sandy soils differently than clay soils?
   c) Do earthworms respond differently to water in sandy soils than in clay soils?

DISCUSSION QUESTIONS

1. The ancient Greek philosopher Aristotle called earthworms "the intestines of the earth". Is this a reasonable description based on your colonies?
2. On open, sloping soil, where surface runoff of excess rainwater is possible, how would earthworm activity influence the tendency for soil to erode?
3. Would you expect to find earthworms in soil that was usually cool and waterlogged? What would happen to organic matter falling on this soil?

RELATED ACTIVITIES

1. When the vivariums have stopped draining, light them from above with an incandescent source and observe the earthworm response.
2. Obtain 30 cm cubes of lawn, garden and filed soil and search them for soil invertebrates. Try to identify any you find and research their ecological niche. In particular, how will they affect the growing of plants for food.
3. Some simple structural and behavioral investigations with earthworms are contained in Chapter 1 of Science Plus 1, Harcourt Brace Javanovich, Canada.



Task Sheet One

Ranch Name ______________________________

Team Members

Number of worms added ____________

Number of days since stocking ________

Water

Volume added ______________

Volume draining ______________

Volume held in soil ____________

Time elapsed before
draining begins ______________

Time elapsed before
draining is complete __________

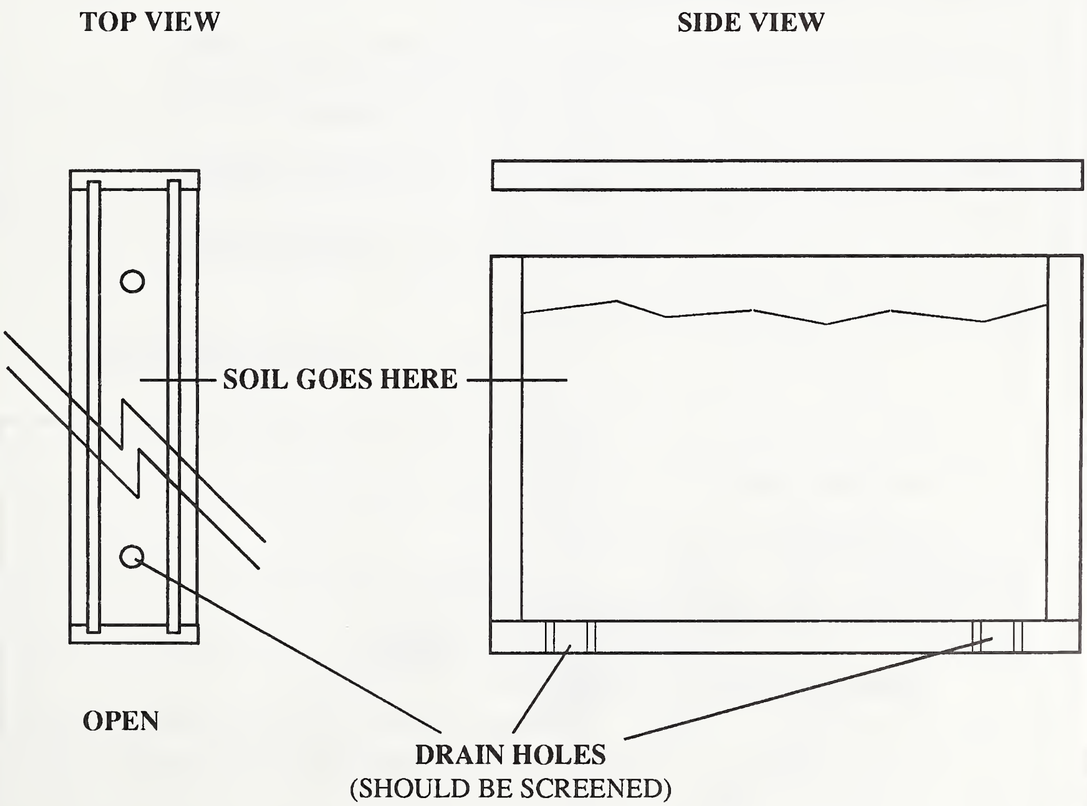
PATH TRAVELLED BY WATER

EARTHWORMS' RESPONSES TO FLOODING

Teacher Resource Sheet One
Building A Worm Ranch

Your worm ranch is a narrow, glass-sided vivarium, commonly known as an ant farm.

It consists of glass held 3-4 cm apart by a frame, with the space between filled with soil.

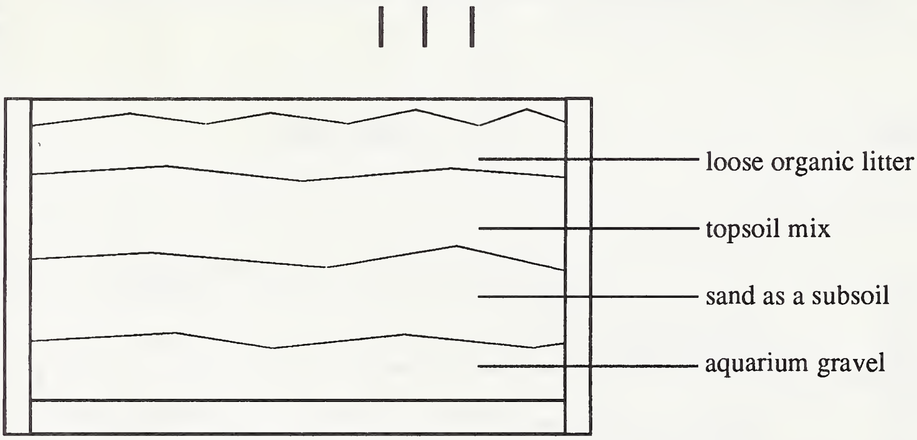


It is important to have opaque covers for each side of the worm ranch. Soil organisms are all highly light sensitive and will only tunnel near the glass if it is covered between observations.

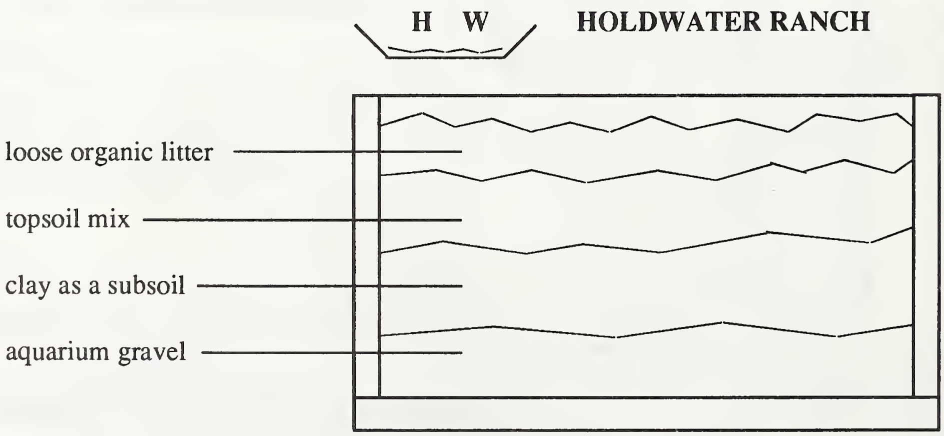
Data Sheet One —
Preparing and Stocking the Worm Ranch

For this activity and Worm Ranch I you need to fill two soil vivariums with layers of soil as illustrated.

SANDYBASE RANCH



HOLDWATER RANCH



The exact depths of each layer is not critical. All layers but the sub-soil should be the same.

Each ranch can be stocked with up to 20 earthworms.

Activity 15

WHERE DID YOU GET THAT?

OBJECTIVE: Students will convert a mass of oral and visual information into a simplified flow diagram.

CURRICULUM FIT: **GRADE EIGHT - SCIENCE**

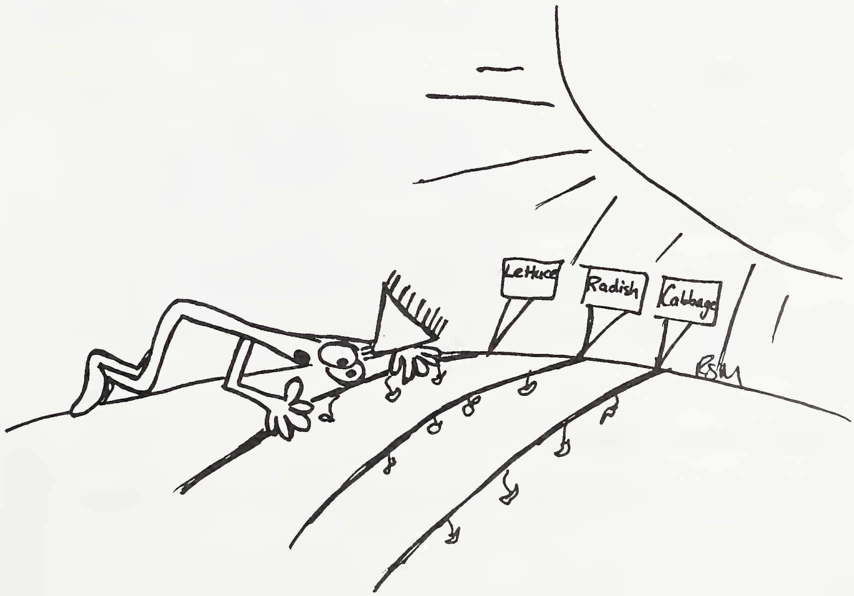
- Topic 5: Growing Plants
- Topic 6: Interactions and Environments
- Soil nutrients and fertilizers
- Food chains and food webs

AGRICULTURE CONCEPTS: Production, processing and distribution system

COGNITIVE LEVEL: Analysis, Synthesis

MATERIALS REQUIRED: Food and Energy Teaching Kit, <u>Plants for Food - Food for Plants</u> (available from Access).

TIME REQUIRED: 50 minutes.



BACKGROUND - For the Teacher

When we go to a fast food restaurant or even to a grocery store, we may not always realize where the food we're getting comes from. Because of processing and packaging, the end product often bears no resemblance to its original source. After all, how many of us think of a dirt-covered potato when we order french fries. Or, how many of us think about cows when we drink milk.

Food goes through many steps before reaching us. But, it is a fact that most of what we eat has its source in the land. For instance, the nutrients in soil help potatoes to grow. The nutrients also help to grow grasses, which feed cows, which produce milk, which we drink. There is a definite chain that links humans to the soil. Without healthy soil to provide us with food, we would perish.

In this activity, your students will get a chance to see the interdependence among living things. They will also get a chance to trace a processed food item back to its origin.

PROCEDURE

Part 1
Preparation

1. Book the teaching kit Plants for Food - Food for Plants from Access. Reserve a VCR and monitor for the same day.

Part 2
Introduction

2. Introduce the video and explain that students will be asked to draw a flow chart that summarizes the process by which they get a hamburger and french fries.

Part 3
Activity

3. Show the video cassette Plants for Food - Food for Plants. (This runs for 13 minutes.)
4. Ask students to make a flow chart that traces the parts of a restaurant order of a hamburger and fries back to their origins as plants and plant nutrients. Allow them 15 minutes to make as complete a chart as they can.

Part 4
Conclusion

5. Ask student to contribute steps to the building of a composite chart on the chalkboard or an overhead projector slide.

DISCUSSION QUESTIONS

1. Are there intermediate steps to this process that weren't mentioned in the video but that we know anyway?
2. How is this process like and unlike a food chain in nature?
3. In the nutrient cycles for nitrogen, phosphorus and potassium, what step is the source of the nutrients in chemical fertilizers?

RELATED ACTIVITY

1. Make a collage (as a class) of the process identified in the flow diagram.

Activity 16

HOW MUCH FOOD FOR PLANTS?

OBJECTIVE: Students will calculate the amounts of various commercial and non-commercial fertilizers needed to supply nutrients for crops.

CURRICULUM FIT: GRADE EIGHT - SCIENCE
- Topic 5: Growing Plants
- Soil nutrients and fertilizers
- Calculating accurately
- Drawing conclusions from evidence

AGRICULTURE CONCEPTS: Technology and capital intentity
Production, processing and distribution system

COGNITIVE LEVEL: Application

MATERIALS REQUIRED: Food and Energy Teaching Kit, Plants for Food - Food for Plants (available from Access).

TIME REQUIRED: 50 minutes.

> **NOTE**
> This is an especially good idea for a science fair project.

BACKGROUND - For the Teacher

Soil is a living, complex and fragile medium. The organic matter, micro-organisms and nutrients in it nourish plants and help sustain life on Earth.

Therefore, it is important that farmers take proper care of the soil to guard against loss of fertility and soil erosion. Land must be used wisely, and not be exploited and exhausted merely for gain. Yet, farmers have to make a living.

This is where the philosophy of sustainable agriculture comes in. A sustainable farm produces profitable amounts of crops, while being as environmentally safe as possible. Sustainable agriculturists combine traditional conservation methods with modern technology.

For example, they use organic fertilizers like manure and legume crops to replace nutrients and keep the soil healthy. But, if the need arises, they will also use chemicals, which despite a growing negative reputation, can be useful and practical in some circumstances.

Basically, the approach of sustainable agriculturists is to produce optimum yields using the least possible amounts of chemicals and other non-renewable resources.

However, all farmers, whether they regard themselves as sustainable agriculturists or not, must respect the life-giving soil and nurture it well for future generations.

PROCEDURE

Part 1 Preparation	1.	Book the teaching kit <u>Plants for Food - Food for Plants</u> from Access. Reserve a VCR and monitor for the same day.
	2.	Make a copy of the task sheet for each student. Make enough copies of the data sheet that working groups of 4 will each have a set.
Part 2 Introduction	3.	Show the video <u>Plants for Food - Food for Plants</u> to introduce the ideas that plants require nutrients from the soil, and that the needs of plants may exceed the supplies in soils.
	4.	Organize the students into groups of four and give each group a set of the data sheets.
Part 3 Activity	5.	Distribute copies of the Task Sheet to each group and ask them to prepare a group fertilizer plan in the shortest possible time.
Part 4 Conclusion	6.	Have each group present their plan and explain why it is the best one available.

DISCUSSION QUESTIONS

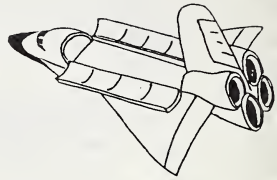
1. If you apply 90 kg of ammonium nitrate fertilizer, which is 34% available nitrogen, to one hectare of land, how many kilograms of nitrogen are available to plants there?
2. How many pounds of feedlot cattle manure would you need to supply the same nitrogen to that hectare?
3. What information would you need to calculate how many cattle it would take to supply all the nitrogen needed on a 100 hectare field? Where would you look for this information?
4. Account for the tendency of modern farmers to use chemical fertilizers rather than animal manure?
5. What kinds of fertilizer does your family use?

RELATED ACTIVITIES

1. Develop a plan for a food-producing home that comes as close as possible to totally providing the fertilizers and food products it needs.
2. Write to:

   Sustainable Agriculture Association
   Box 1063
   Nanton, Alberta
   T0L 1R0

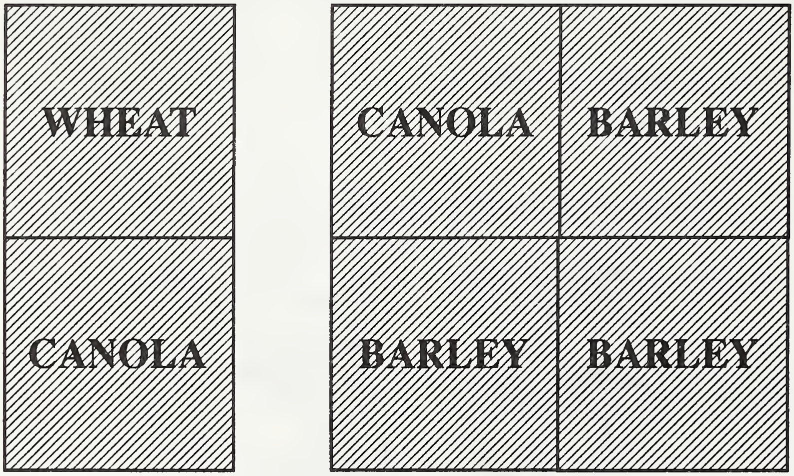
   and ask them about their position on fertilizer use.



Data Sheet One
The Farm

You own and operate a farm, diagrammed below, in north-central Alberta. Each parcel shown is 64 hectares for a total area of 384 hectares.

This year you are planting the crops shown on the diagram.



CANOLA:	Usually yields well and matures before frost. Price is highly variable.
BARLEY:	High yields and lowest chance of loss to frost. Price is generally low.
WHEAT:	Can produce high yields, but is likely to be lost due to frost. Sells at a high price.

To get the best economic yields you are going to fertilize your crops according to the recommendations on Data Sheet 3.

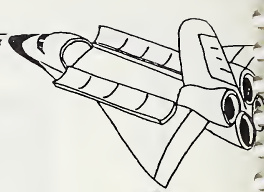
Data Sheet Two -- Common Fertilizers

NAME	ANALYSIS	FORM	COST/Tonne SPRING '89 ***	METHOD OF APPLICATION	TIME APPLIED
Anhydrous Ammonia	82-0-0	gas compressed to liquid	$360	Requires a special applicator to inject gas into soil	Early spring
Urea	46-0-0	granules	$285	Applied with seed drill during planting	During planting
Ammonium Nitrate	34-0-0	granules	$215	Applied during planting	During planting
Ammonium Phosphate	16-20-0 11-51-0	granules granules	$290 $360	Applied during planting Applied during planting	During planting During planting
Ammonium Sulfate	20-0-0-24	granules	$195	Applied during planting	During planting
Potash	0-0-62	granules	$190	Applied during planting	During planting
Sulfur	0-0-0-90	granules	$250-300	Applied during planting	During planting
Feedlot cattle manure	0.6-0.1-0.4**	dried & chopped solid		Aged for 1 - 2 years in pile; spread on surface and tilled in	Late fall or early spring
Swine manure	0.6-0.2-0.4**	slurry in water		Diluted and sprayed on ground surface	Late fall or early spring
Poultry manure	1.5-0.5-0.4**	dried & chopped solid		Aged for 1 - 2 years in pile; spread on surface and tilled in	Late fall or early spring
Sheep manure	1-0.2-0.8**	dried & chopped solid		Aged for 1 - 2 years in pile; spread on surface and tilled in	Late fall or early spring

* The numbers given are the percentages in order of Nitrogen, Phosphorus and Potassium contained in the fertilizer. If there is a fourth number it represents the percentage of Sulfur present. Where total nutrient percentage is less than 100, the remainder is an inert filler.

** Analysis based on fresh manure mixed with urine and bedding.

*** Prices vary with supply and demand for each product.

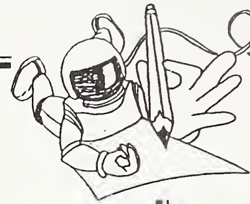


Data Sheet Three
Fertilizer Recommendations

Following a soil test you are advised to fertilize as follows:

For CANOLA:	*17-20-0-15 at 70-90 kg/Ha
For WHEAT:	82-0-0 at 45-75 kg/Ha (early spring) 11-51-0 at 45 kg/Ha (at seeding)
For BARLEY:	82-0-0 at 45-70 kg/Ha (early spring) 11-51-0 at 45-70 kg/Ha (at seeding)
	or
	61-20-0 at 45-70 kg/Ha (at seeding)
For OATS:	82-0-0 at 45 kg/Ha (early spring) 34-0-0 at 90 kg/Ha (at seeding)

***pre-blended compound; can be mixed by using 20-0-0-24 and 11-51-0.**



Task Sheet One

Your task is to develop a fertilizer plan for your farm.

To produce a successful plan you will need to do the following:

*Calculate the total amount of fertilizer needed for each crop.

Total amounts where one fertilizer will work on two crops.

Determine the cost of alternatives where they are possible.

Calculate the total cost of your fertilizer program.

***Choose one of the manure fertilizers listed first. See how much you can get done with it and then add the appropriate amount of chemical fertilizer you need to bring your total to the recommended level.**

HINT: Aim to use the minimum number of kinds of fertilizer as this will simplify application and reduce costs.